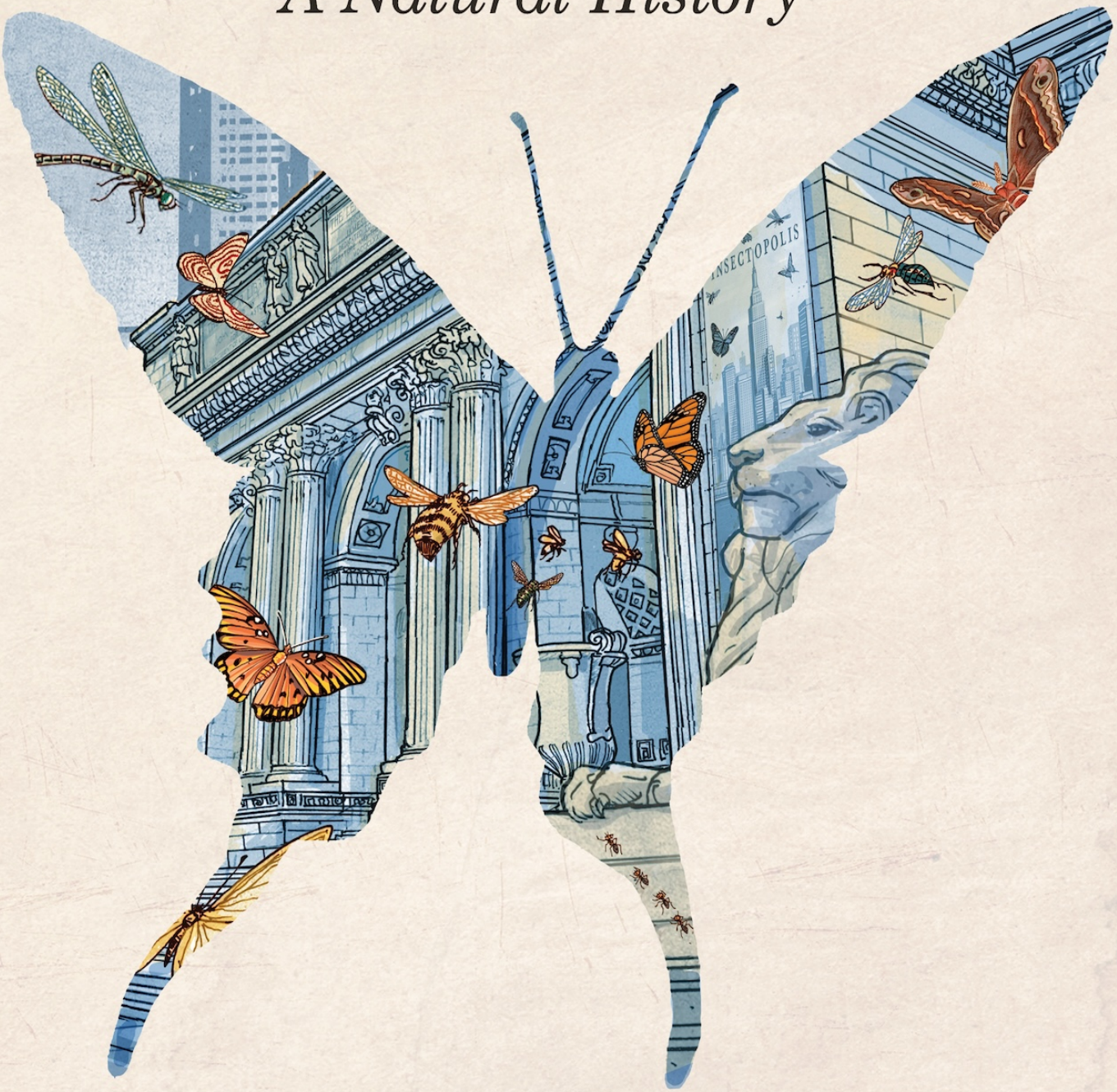
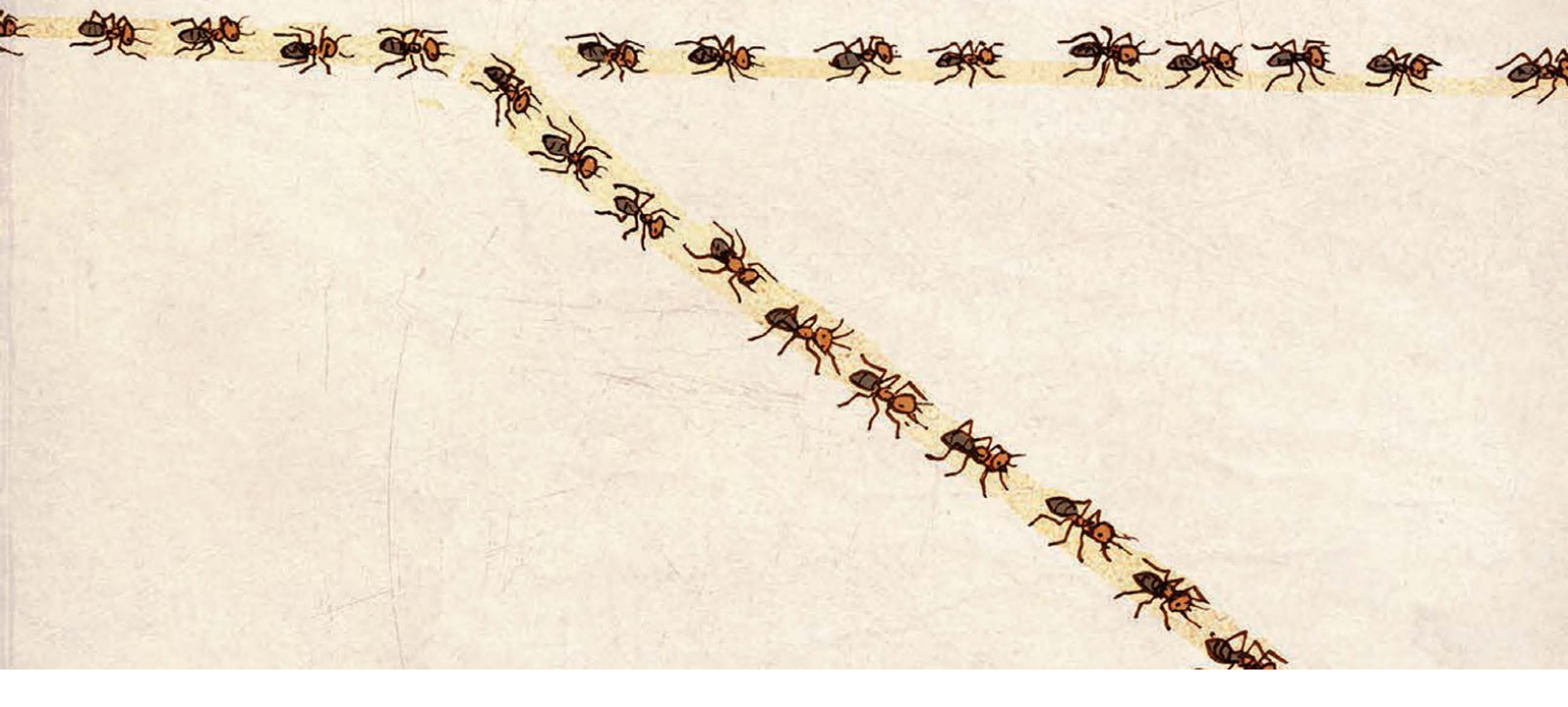
INSECTOPOLIS

A Natural History



PETER KUPER



Peter Kuper

INSECTOPOLIS

A Natural History

XVII.
Wunder- raupen.
Vermes miraculosi.
Diese zwey grosse Raupen / welche einander
sehr ungleich an ihrer Gestalt und Farbe / haben
sich zu einerley Zeit / und zwar im May / befun-
den ; die mir etlichsmal einige hohe Liebhaber über-
schickt / und haben sagen lassen / auch selbst zu mir gesagt /
daß sie dieselben in dem Gras angetroffen : Weiß dem-
nach / ausser dieser / keine andere Spisse für sie zu melden /
wiewol ich solches gern glaube / weil die am 32. Ku-
pferblat vorkommende Raupe ebenmässig Gras bey
meinem Zuschauen gessen ; und sie alle drey so wol im
Spinnen / als in denen Dattelkernen und Motten-ub-
gein / einander gantz gleich worden / also daß gar kein Un-
terscheid darzwischen zu verspüren war. Diese unterste
grosse Raupe nun ist weiß / von oben zu beeden Sei-
ten mit schwartzen / grossen Flecken / von unten
mit etwas hellen / kleinern geziert / hat vornen
am Kopf zwey braune Büschel Haare / und an
allen andern Gliedern hat sie / unten an beeden
Seiten / wie lange / runde Wartzen / mit braunen
Haaren ; zu Ende auf dem Rucken findt sich ein

W. W. NORTON & COMPANY

Independent Publishers Since 1923

Dedicated to
entomologists
and arthropods
the world over.

INSECTOPOLIS
It is estimated that there are ten quintillion (10,000,000,000,000,000,000) insects on earth

If all mankind were to disappear, the world would regenerate back to the rich state of equilibrium that existed ten thousand years ago.

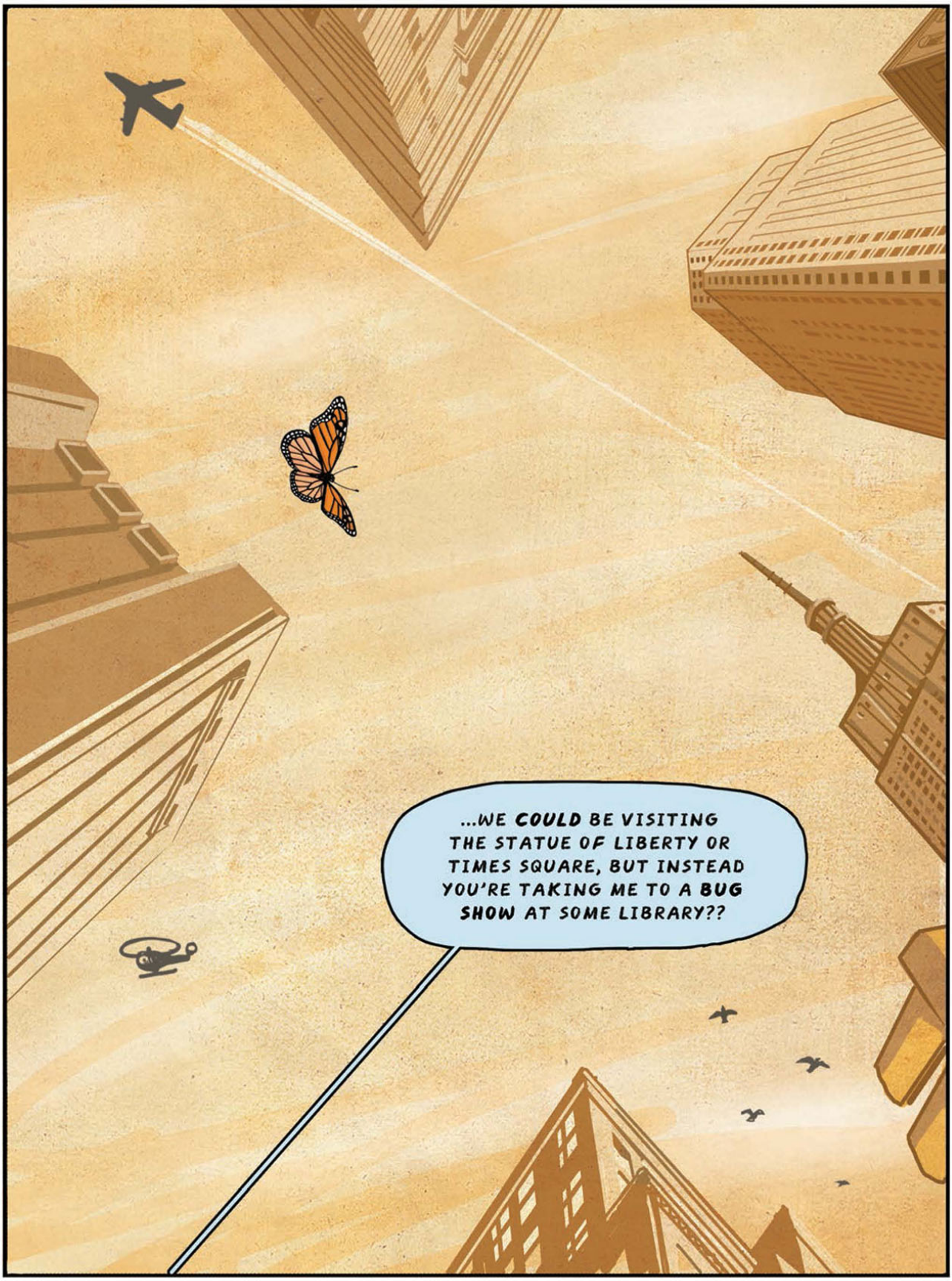
If insects were to vanish...

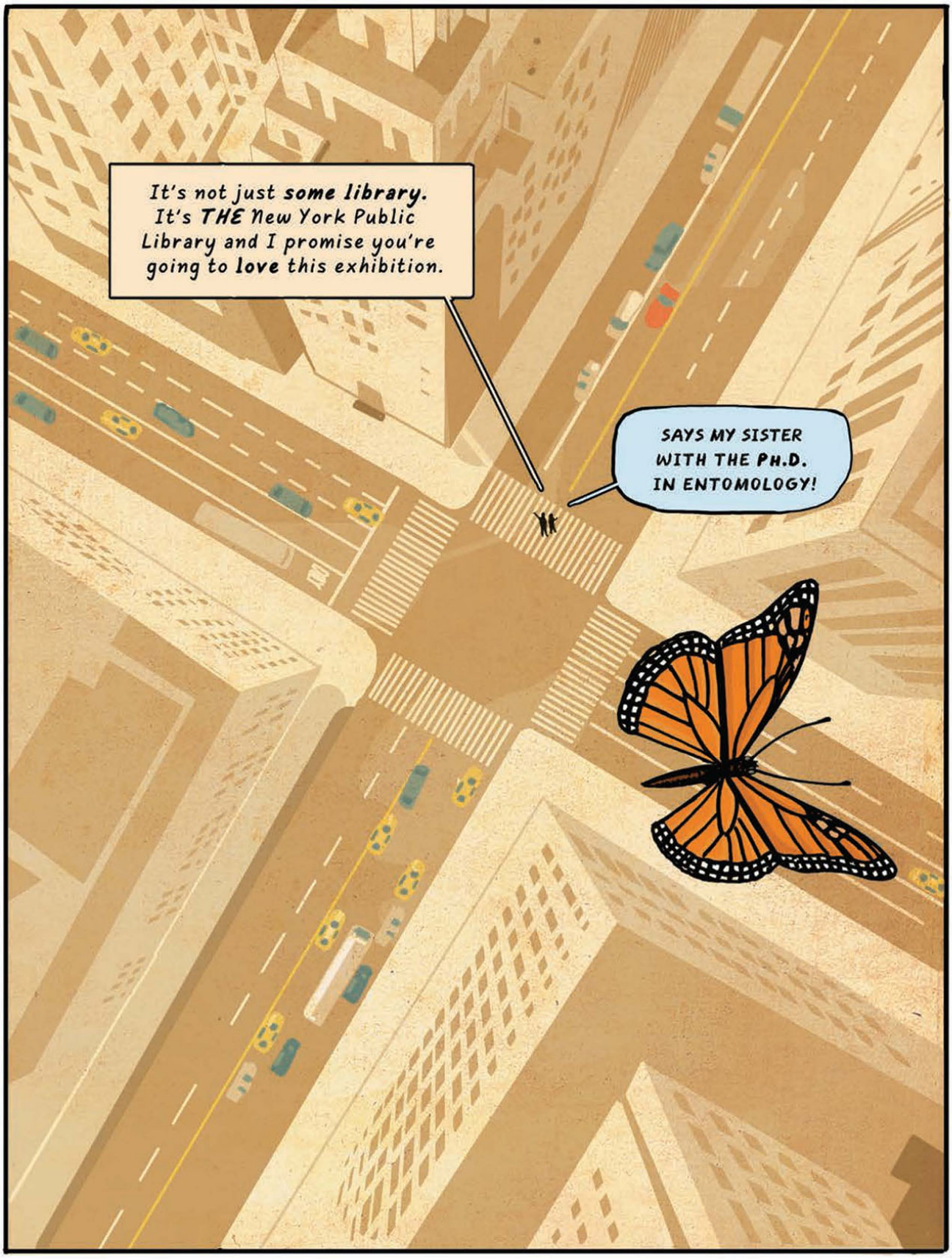
the environment would
collapse into chaos.

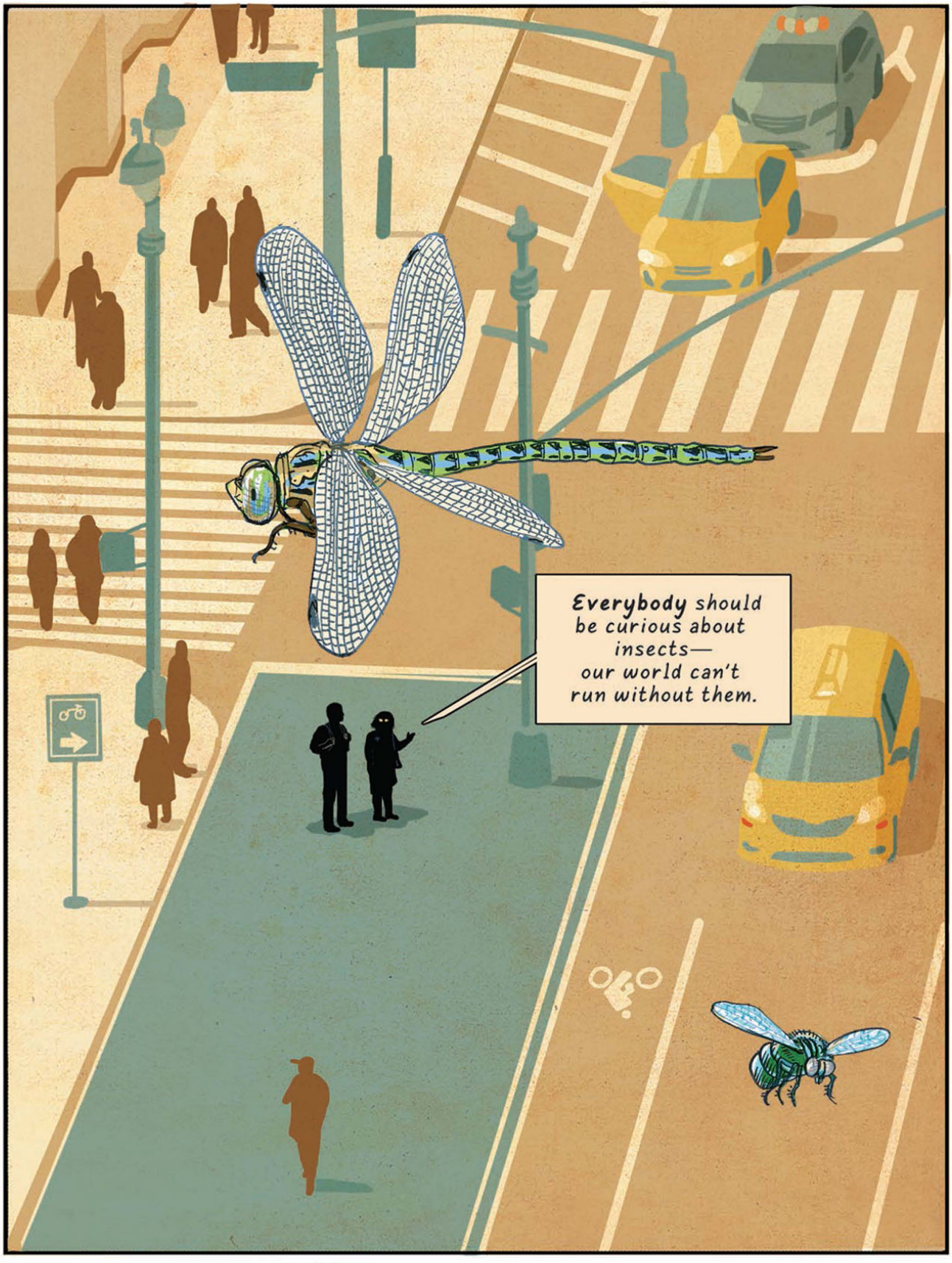
—E. O. Wilson
(1929–2021)

NEW YORKER

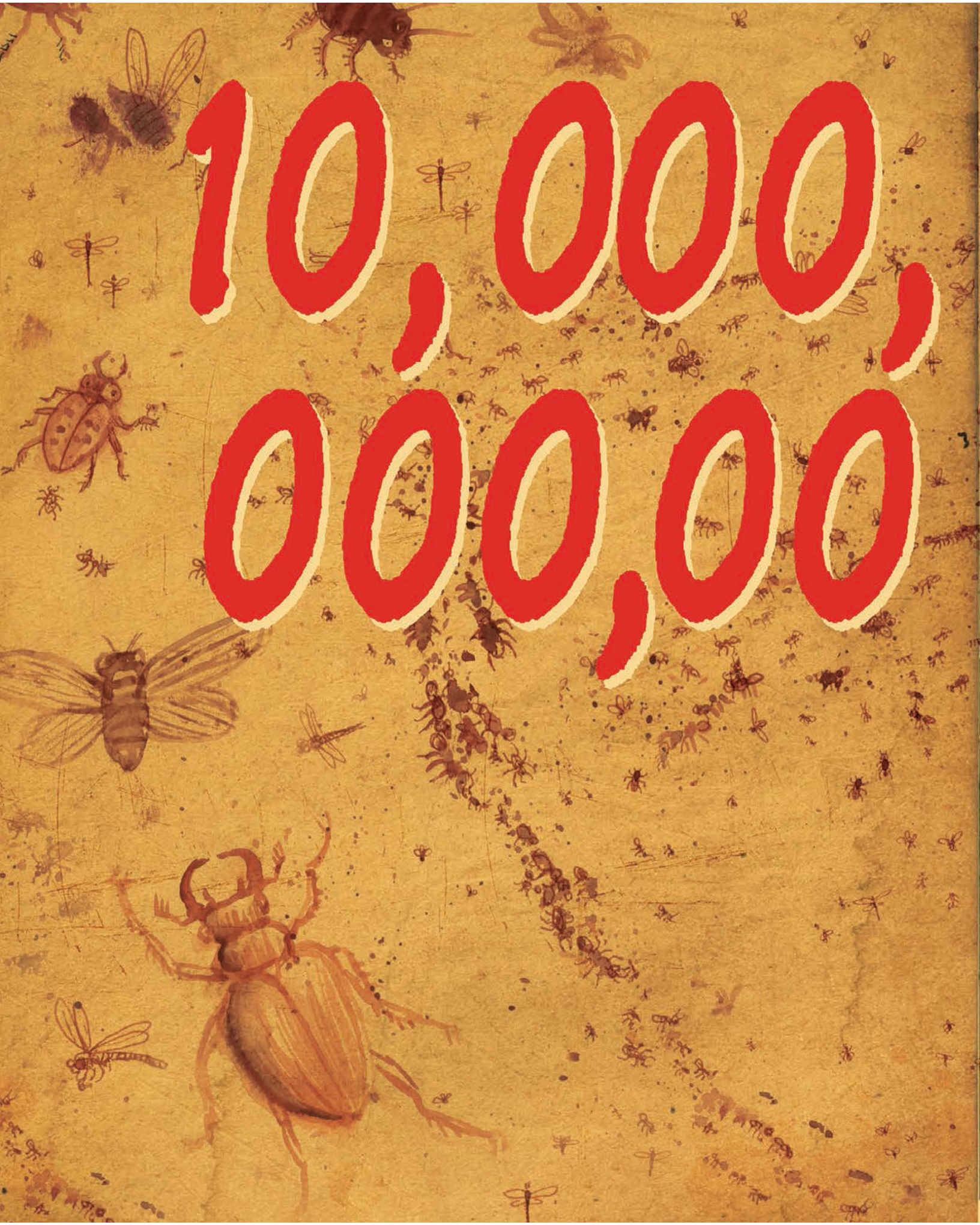
NEW
YORK


...WE COULD BE VISITING THE STATUE OF LIBERTY OR TIMES SQUARE, BUT INSTEAD YOU'RE TAKING ME TO A BUG SHOW AT SOME LIBRARY??


It's not just **some library.** It's **THE** New York Public Library and I promise you're going to **love** this exhibition.
SAYS MY SISTER WITH THE PH.D. IN ENTOMOLOGY!

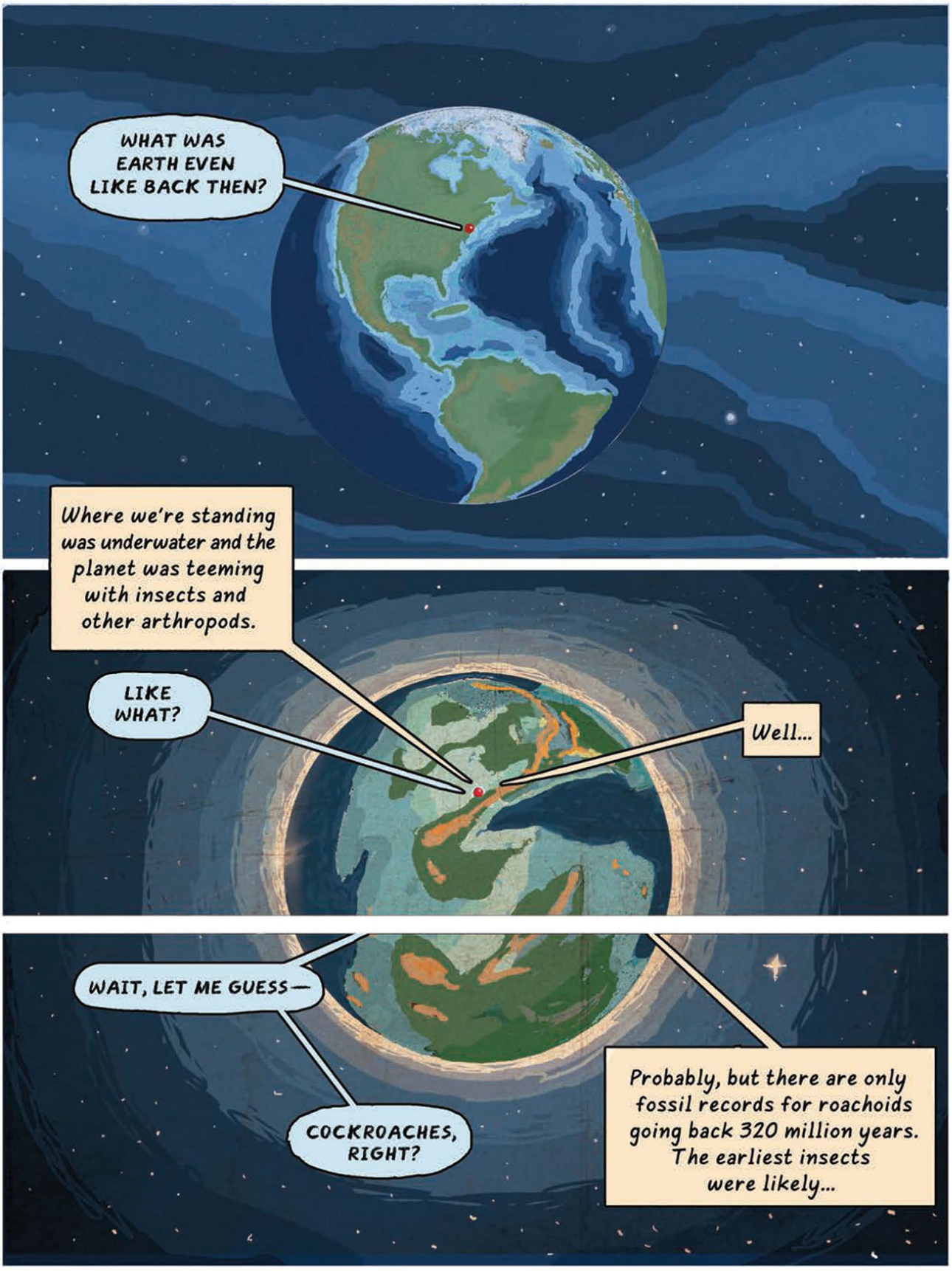

Everybody should be curious about insects— our world can't run without them.

Eighty percent of all species are insects. It's estimated there are **ten quintillion bugs!**
QU-WHAT?? DOES THAT NUMBER REALLY EXIST?

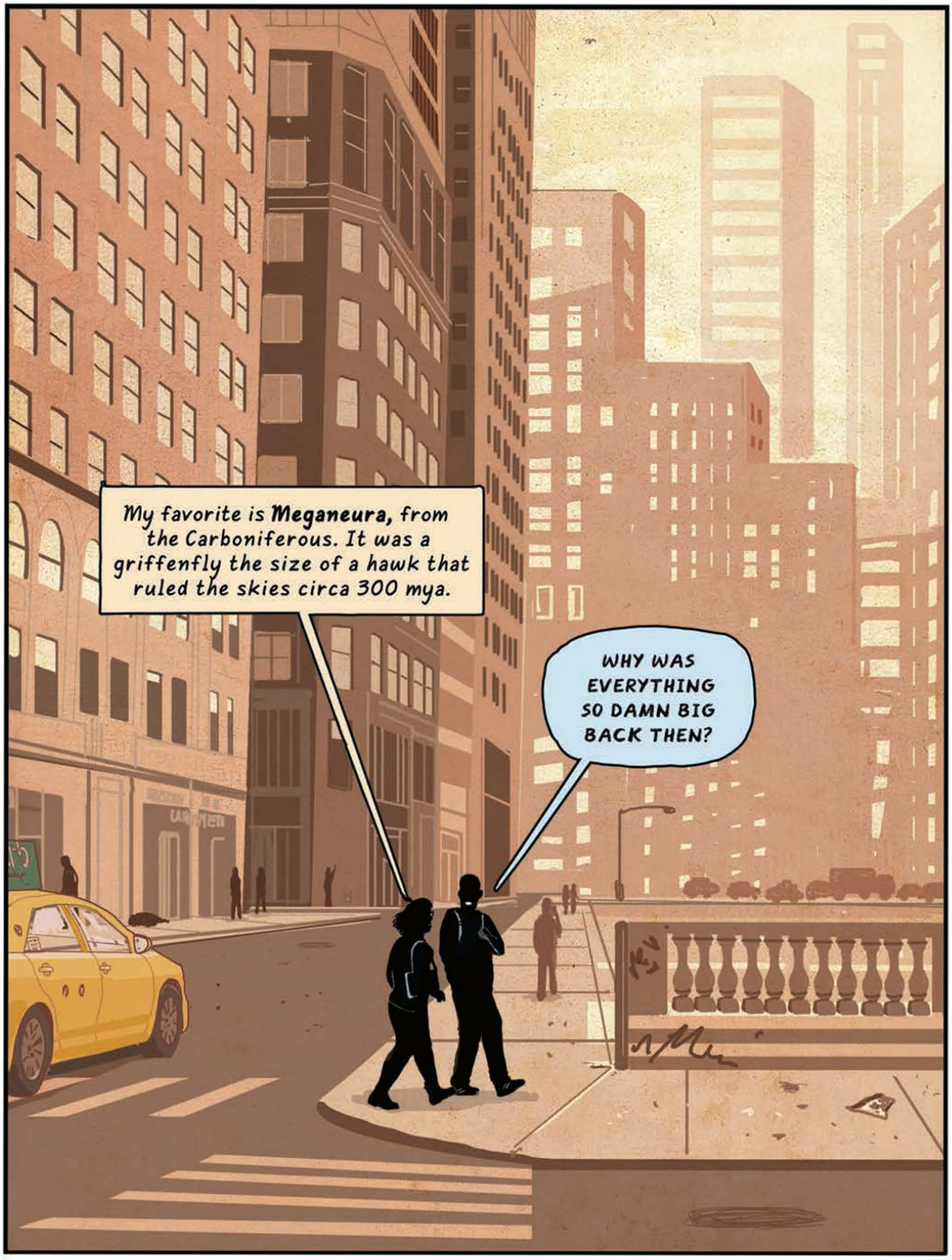

10,000,
000,00

000,000,
0,000
Yep! It's a ten with eighteen zeros after it.
Which means there are 1.25 billion insects for each one of us!
AND YOU WONDER WHY THEY CREEP ME OUT SOMETIMES?

SO HOW LONG HAVE THESE LITTLE CRITTERS BEEN AROUND?
They go back to the Devonian Period— over 400 million years.

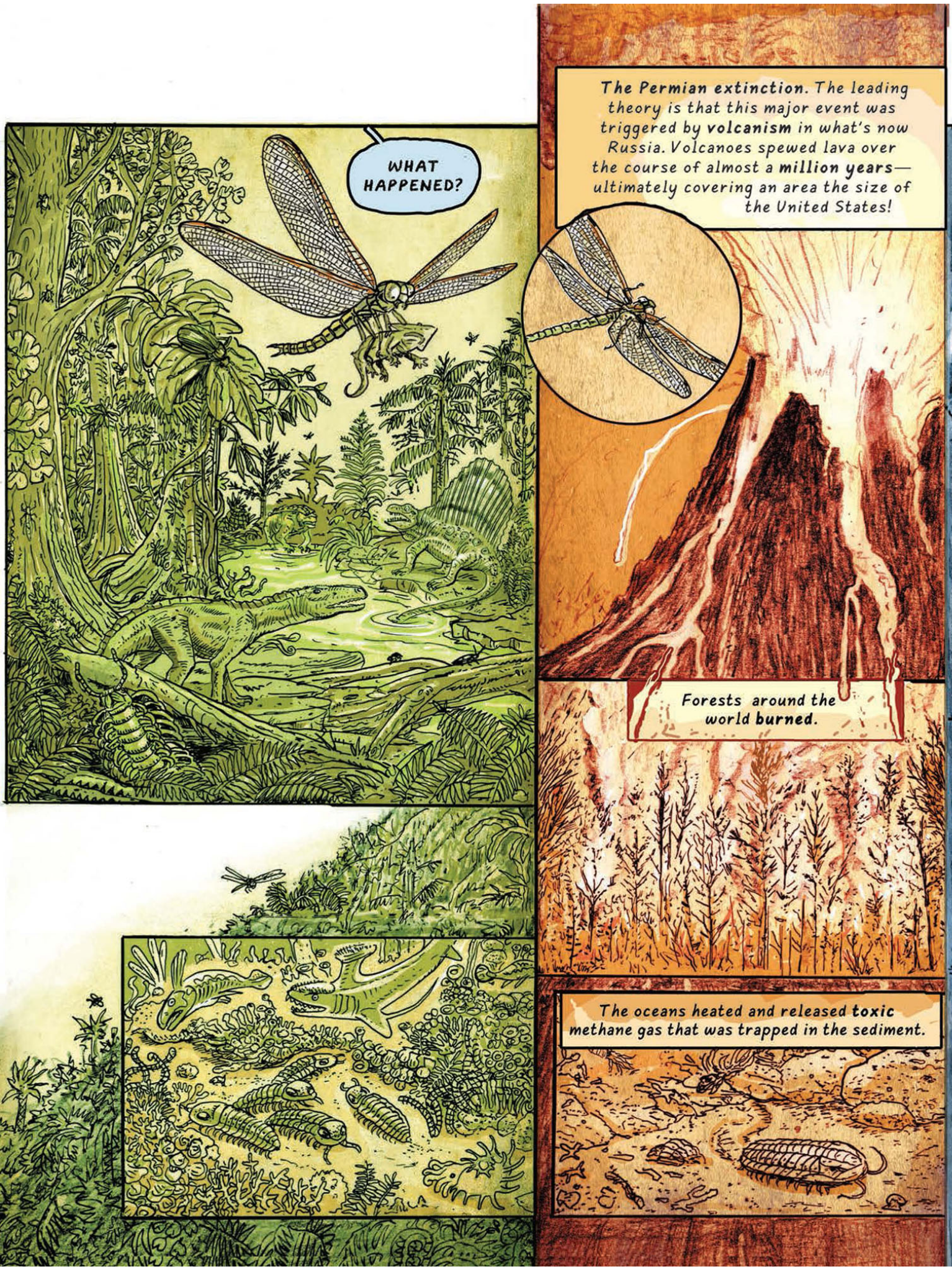

WHAT WAS EARTH EVEN LIKE BACK THEN?
Where we're standing was underwater and the planet was teeming with insects and other arthropods.
LIKE WHAT?
Well...
WAIT, LET ME GUESS—
COCKROACHES, RIGHT?
Probably, but there are only fossil records for roachoids going back 320 million years. The earliest insects were likely...

Silverfish
from as early as 412 mya.
MYA?
That's scientific shorthand for million years ago.
Then there's Rhyniognatha hirsti from 340 mya.
They were the earliest example we've found of a winged insect.
There were also giant millipedes running around called Arthropleura. They were enormous!


My favorite is **Meganeura**, from the Carboniferous. It was a griffenfly the size of a hawk that ruled the skies circa 300 mya.
WHY WAS EVERYTHING SO DAMN BIG BACK THEN?

The oxygen level was **thirty-five percent**, compared with the twenty-one percent we breathe today.
So the respiratory systems of the insects could take in enough oxygen to support a larger physique.
Since birds didn't exist yet, Meganeura had virtually **no** predators and a bottomless food supply, so they grew and grew.

Its reign lasted millions of years through the Permian,
but all good things must come to an end...
ONE WAY


WHAT HAPPENED?
The Permian extinction. The leading theory is that this major event was triggered by volcanism in what's now Russia. Volcanoes spewed lava over the course of almost a million years—ultimately covering an area the size of the United States!
Forests around the world burned.
The oceans heated and released toxic methane gas that was trapped in the sediment.

By 252 mya nearly **everything** on the planet was devastated. It has been dubbed the **Great Dying.**

Eighty-three percent of the insects **vanished.**

Seventy percent of the land-based vertebrate species were **toast.**

And it was even worse for marine life. Ninety-six percent, including the trilobites that had survived for 521 mya—**cooked.**

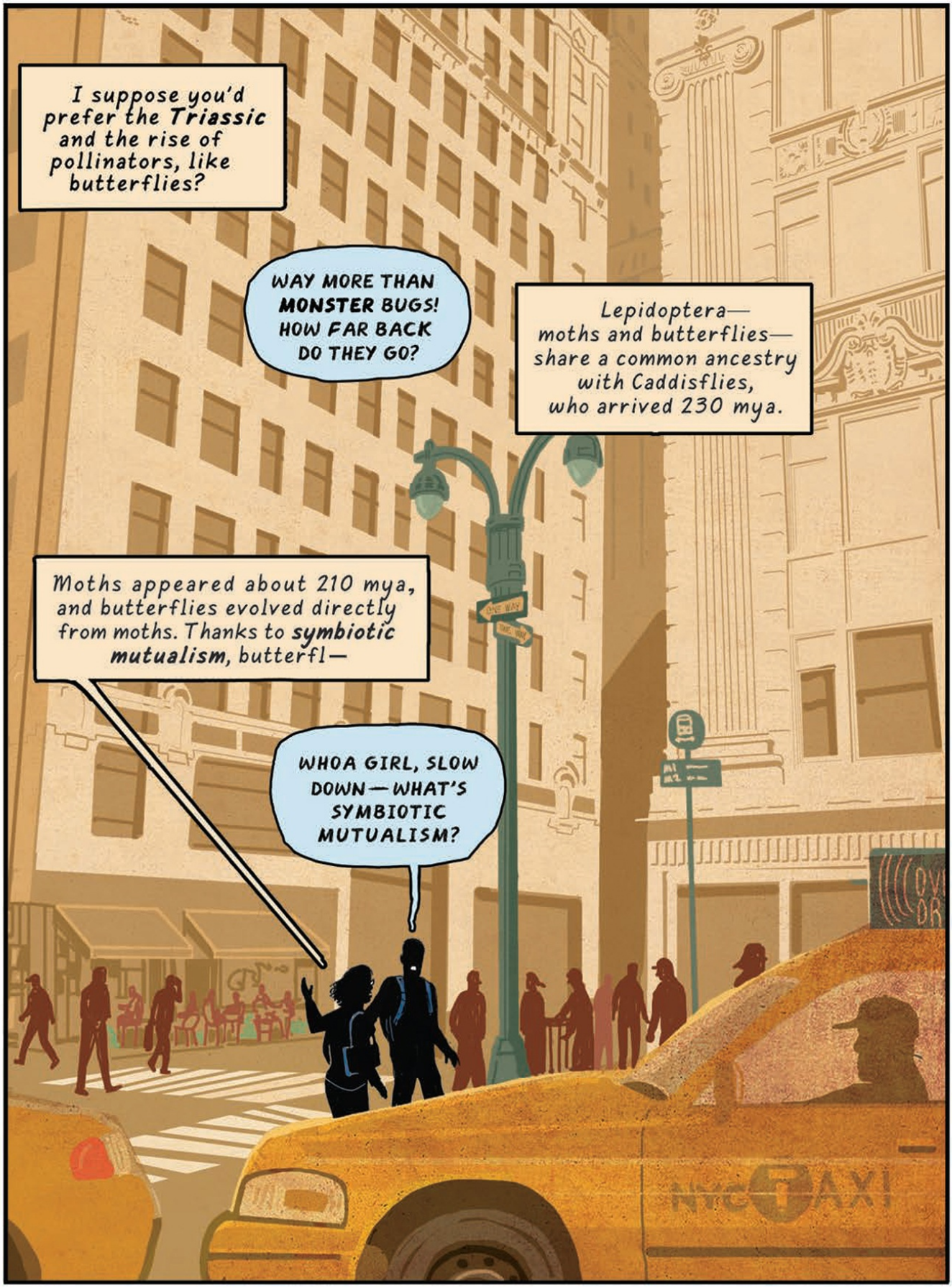
It was almost the end of all life. It took nearly **ten million years** to recover,

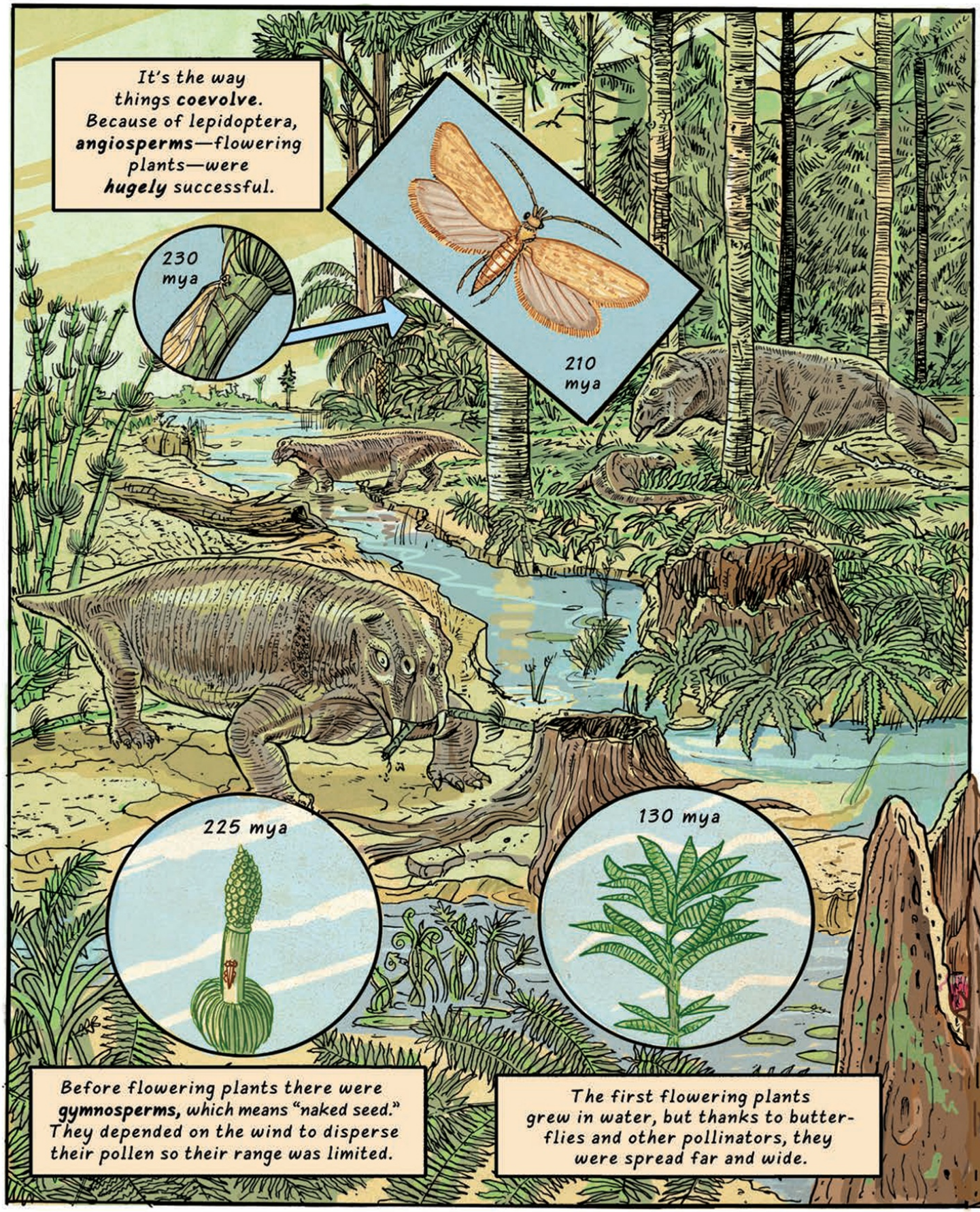
but fortunately for us, it **did!**

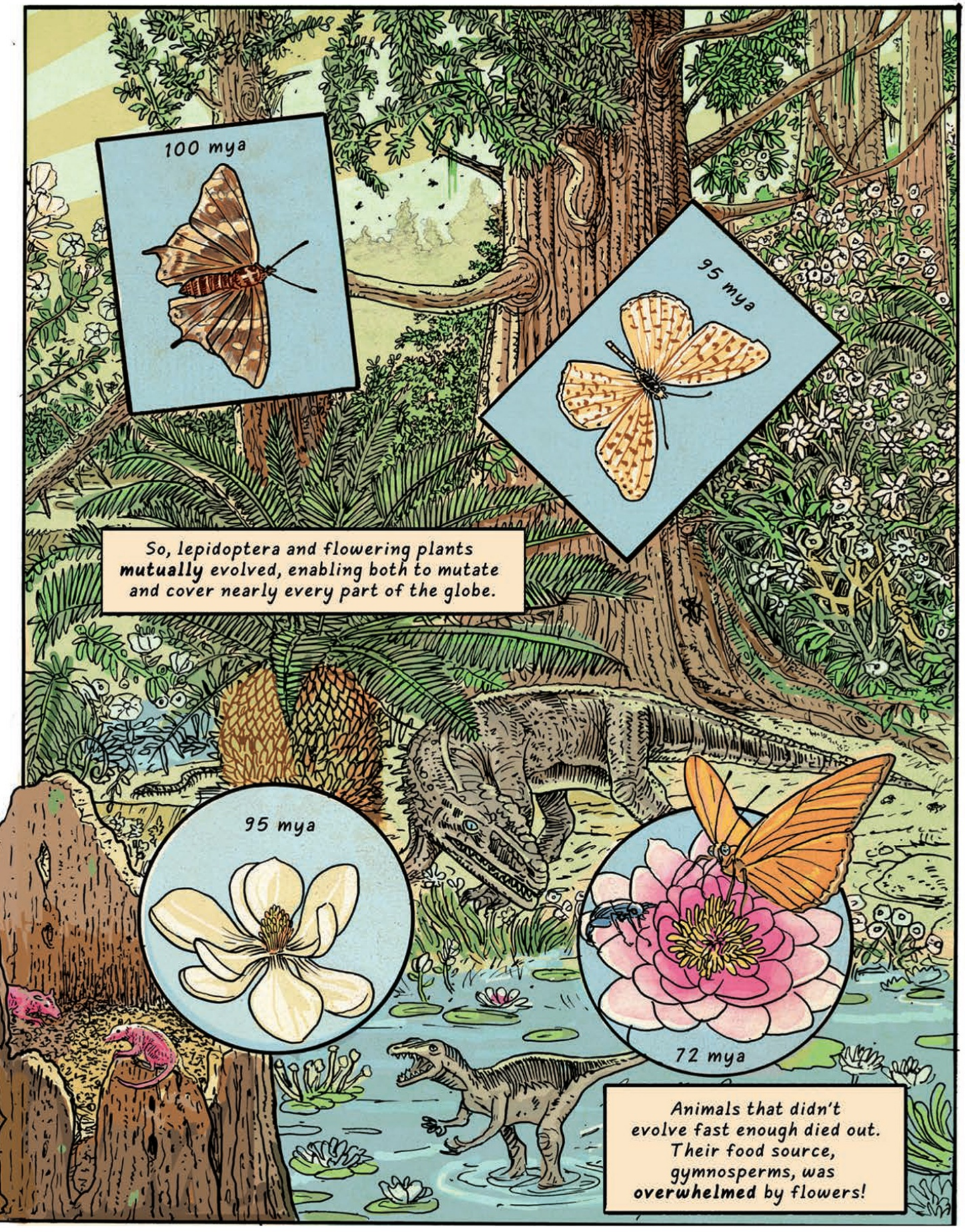
The mammal-like reptile **Diictodon** lived in underground burrows, so they managed to survive along with enough insects to repopulate Earth.

Though sadly, Meganeura were gone **forever.**

A DRAGONFLY THE SIZE OF A HAWK, **GONE?** UM, I'M OKAY WITH THAT.

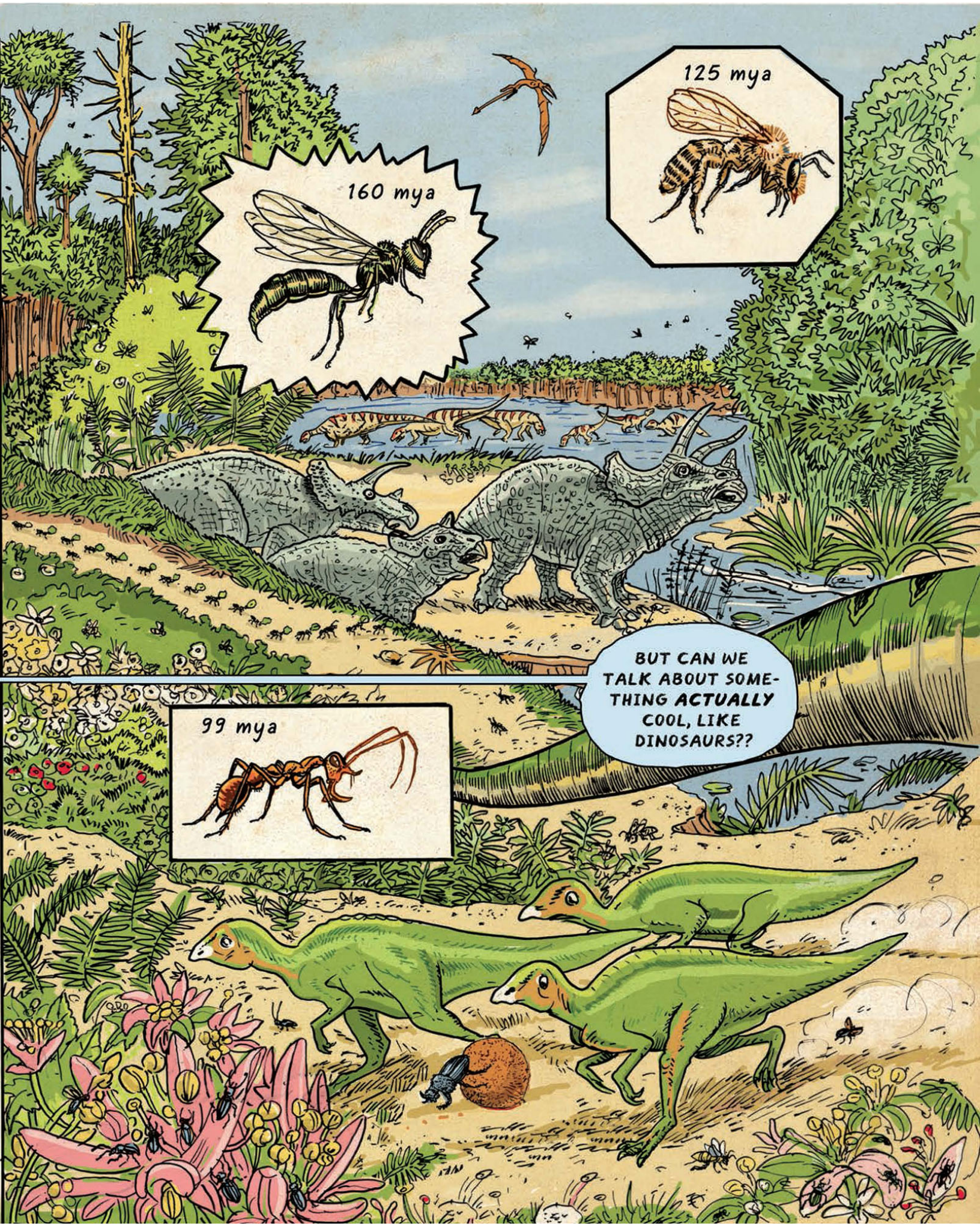

I suppose you'd prefer the **Triassic** and the rise of pollinators, like butterflies?
WAY MORE THAN **MONSTER** BUGS! HOW FAR BACK DO THEY GO?
Lepidoptera—moths and butterflies—share a common ancestry with Caddisflies, who arrived 230 mya.
Moths appeared about 210 mya, and butterflies evolved directly from moths. Thanks to **symbiotic mutualism**, butterfl—
WHOA GIRL, SLOW DOWN—WHAT'S SYMBIOTIC MUTUALISM?
ONE WAY
NYC TAXI


It's the way things **coevolve.** Because of lepidoptera, **angiosperms**—flowering plants—were **hugely** successful.
230 mya
210 mya
225 mya
130 mya
Before flowering plants there were **gymnosperms,** which means "naked seed." They depended on the wind to disperse their pollen so their range was limited.
The first flowering plants grew in water, but thanks to butterflies and other pollinators, they were spread far and wide.

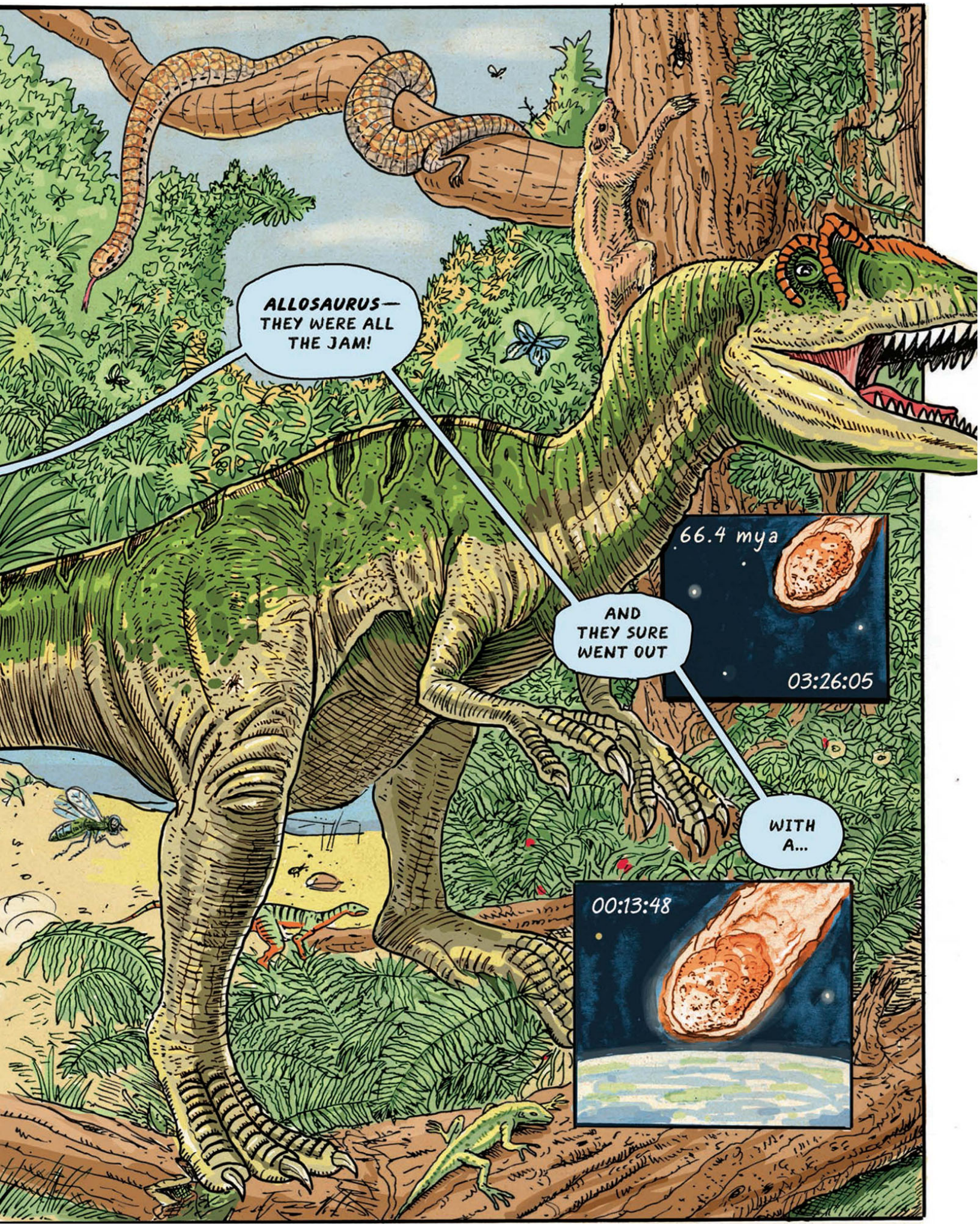

100 mya
95 mya
So, lepidoptera and flowering plants **mutually** evolved, enabling both to mutate and cover nearly every part of the globe.
95 mya
72 mya
Animals that didn't evolve fast enough died out. Their food source, gymnosperms, was **overwhelmed** by flowers!

HAHAHA!
What's so funny??
GYM-NO-SPERM— NAKED SEED! HAHAHA...
Ugh Bro, grow up.

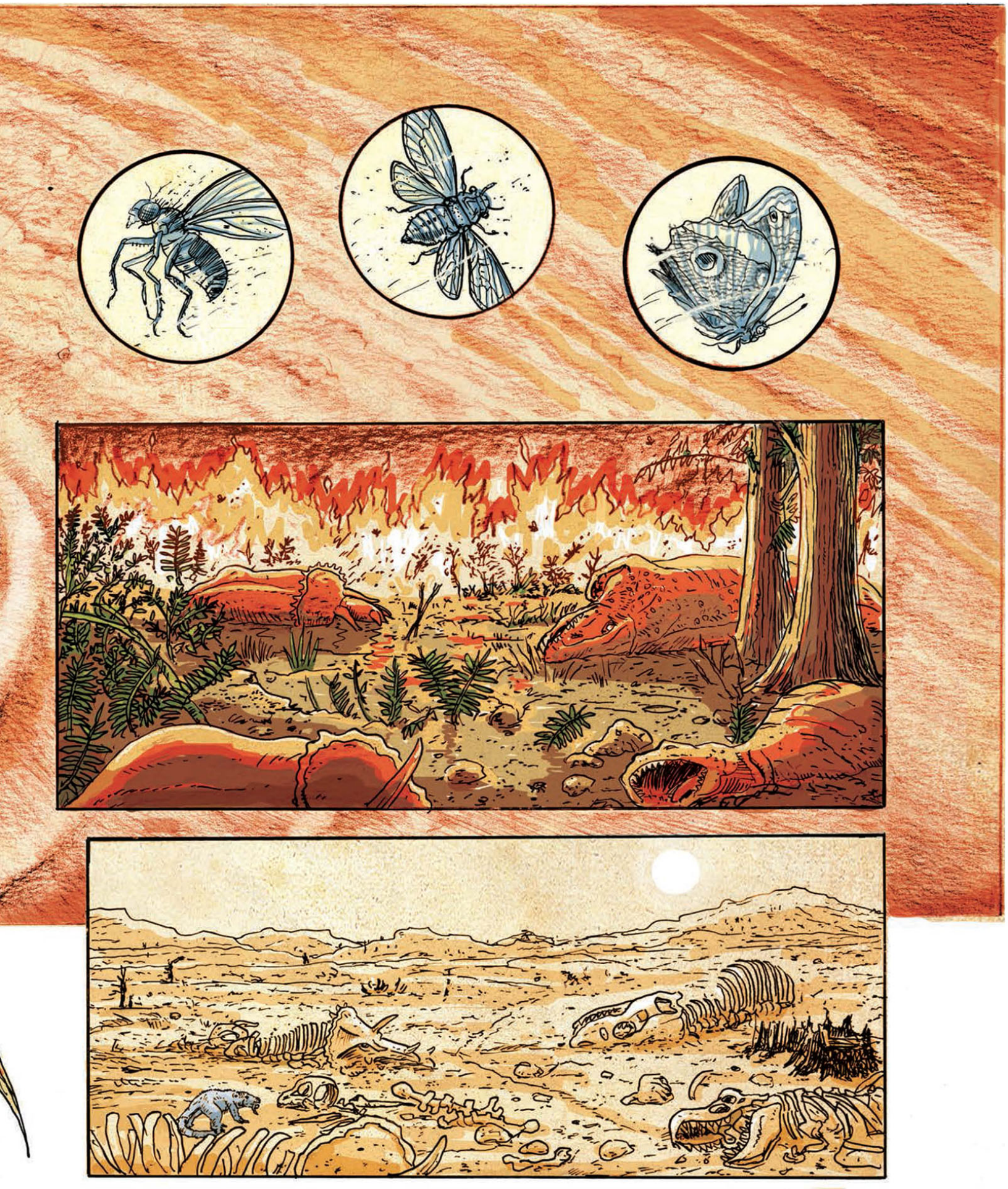
Here's something **really** cool—did you know that bees and ants evolved from wasps?!
UM... FASCINATING.

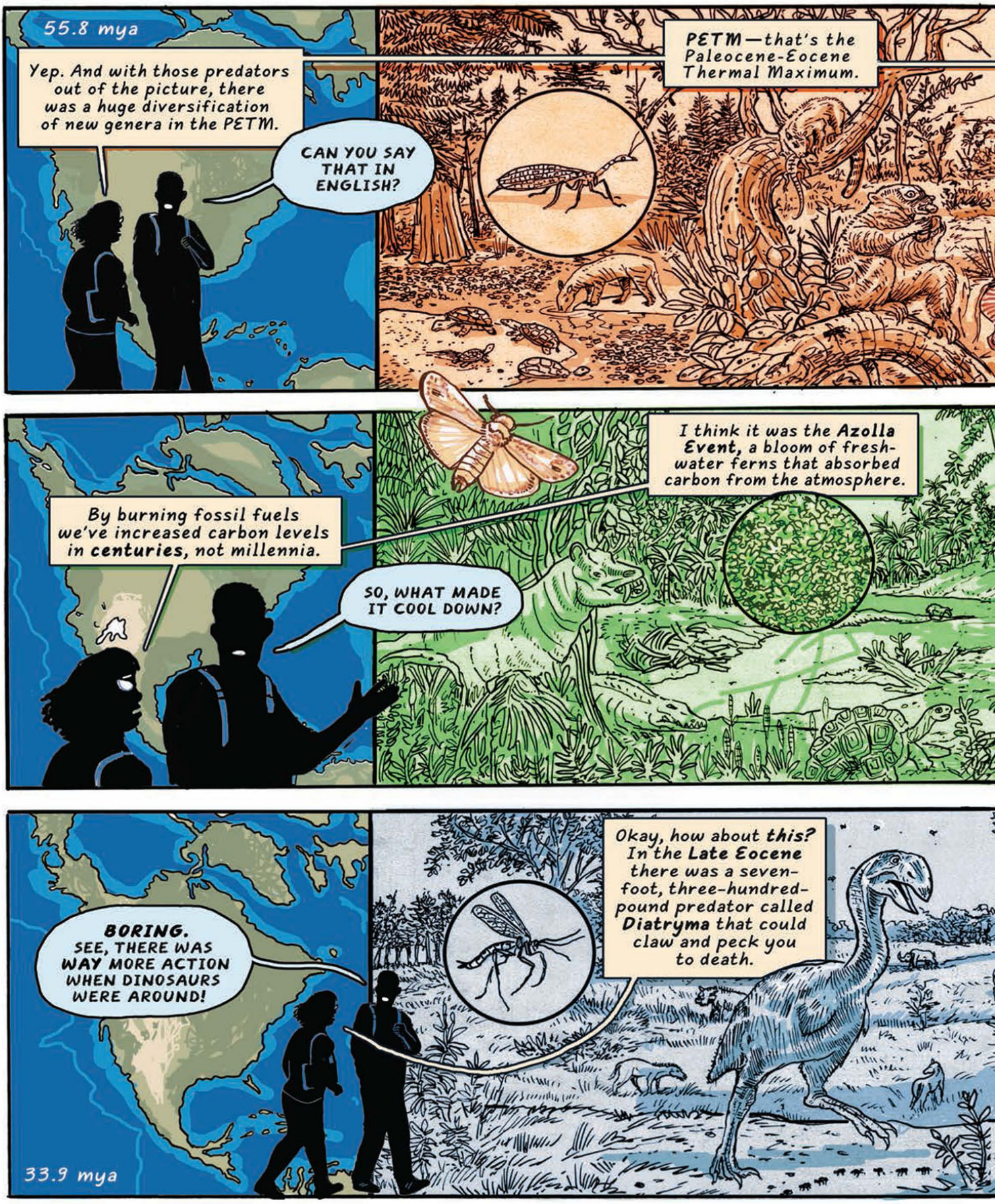

125 mya
160 mya
99 mya
BUT CAN WE TALK ABOUT SOMETHING ACTUALLY COOL, LIKE DINOSAURS??

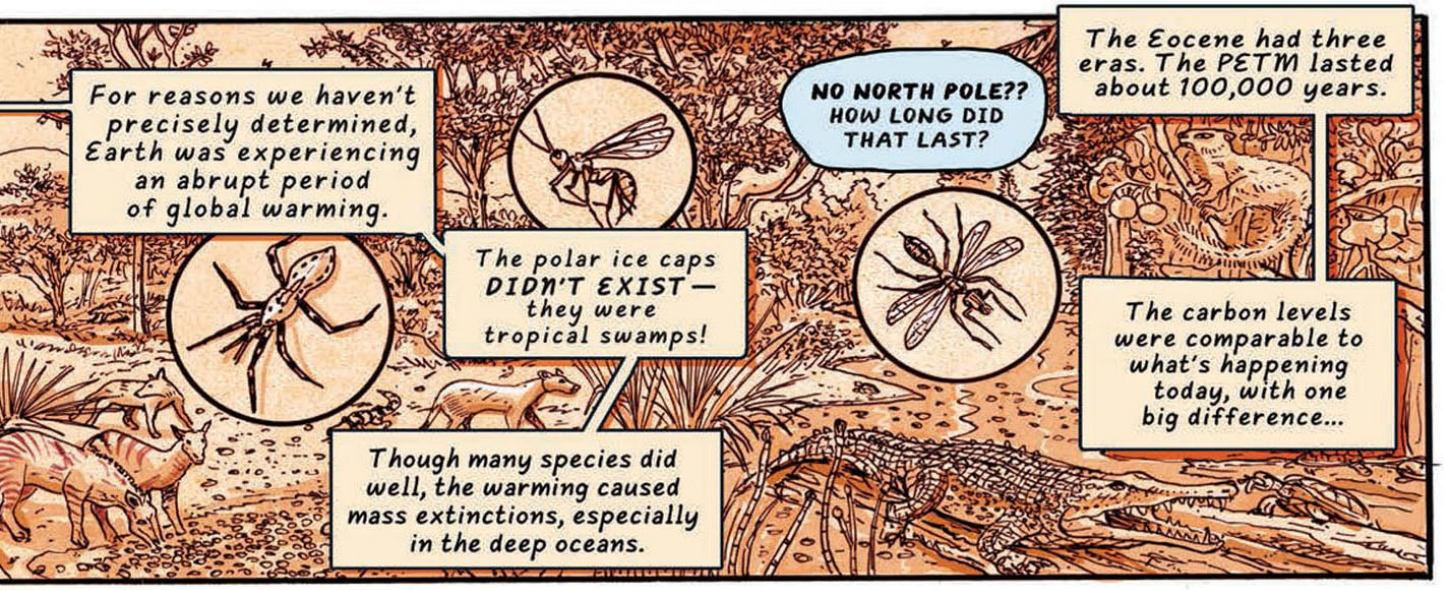
YOU KNOW HOW MUCH I LOVED JURASSIC PARK.
Don't get me started on how many things that movie got wrong!
You know, if you look closely you'll find the history of insects is as dramatic as any—
I'M SURE, I'M SURE, BUT COME ON— VELOCIRAPTORS, T-REX...
2F13
2F13

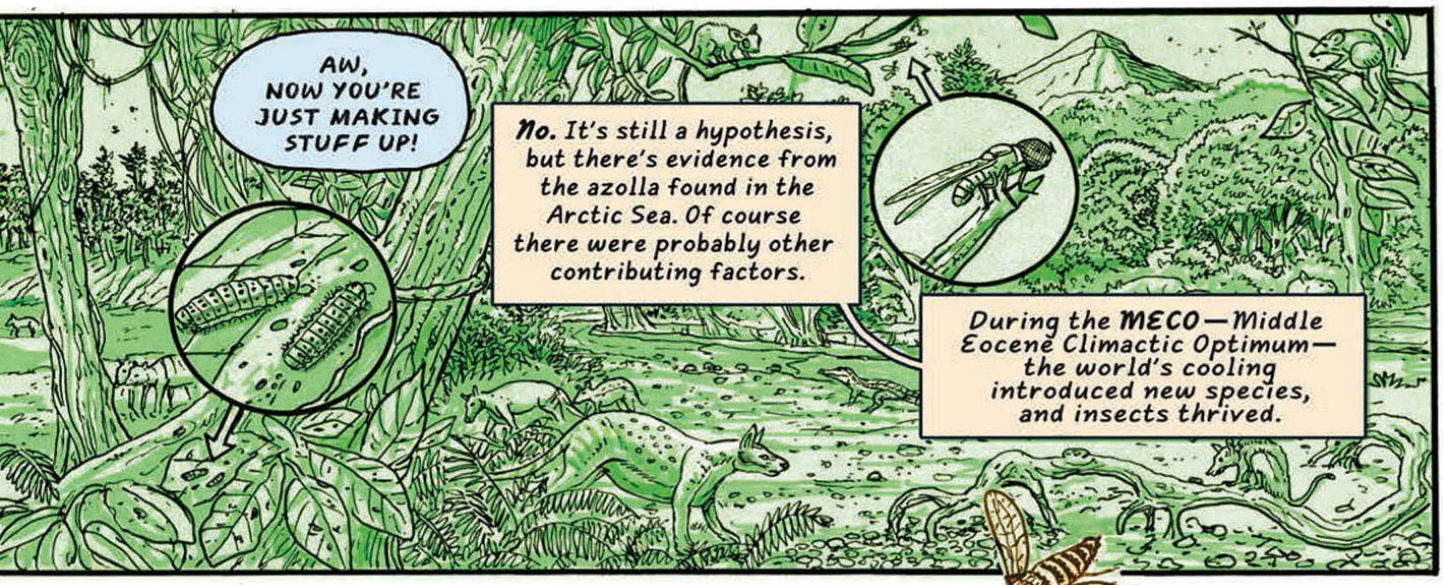

ALLOSAURUS— THEY WERE ALL THE JAM!
66.4 mya
03:26:05
AND THEY SURE WENT OUT
WITH A...
00:13:48

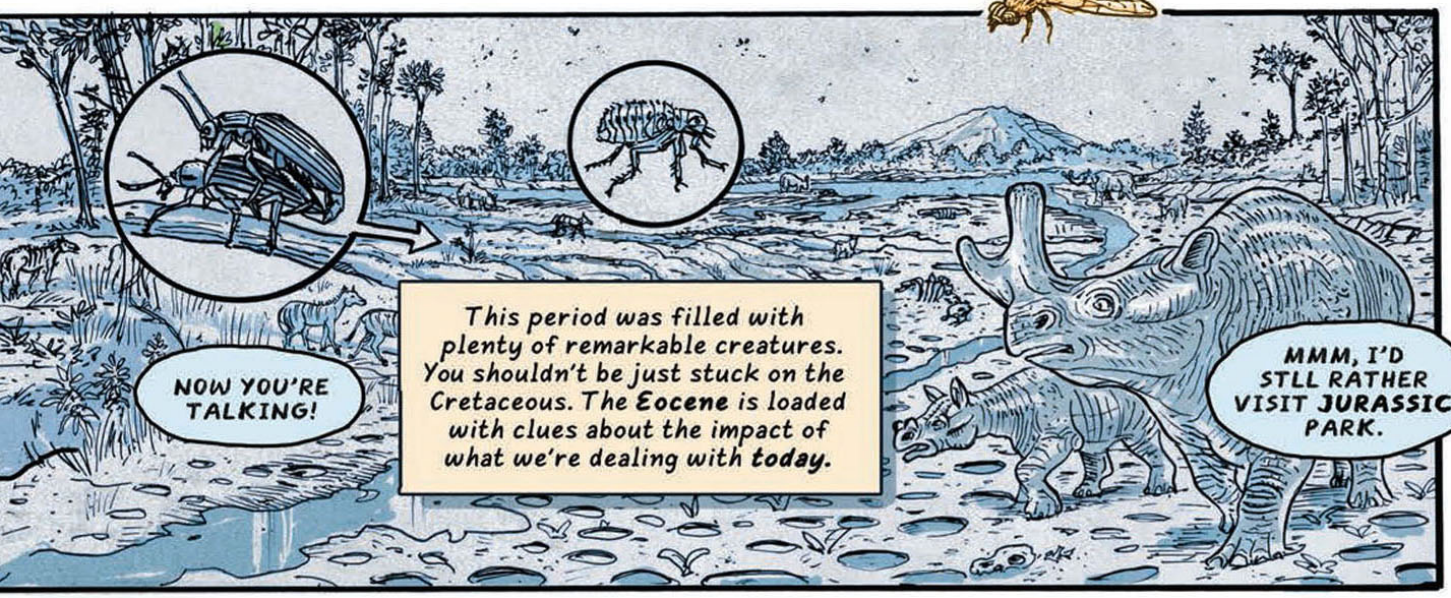
BANG!

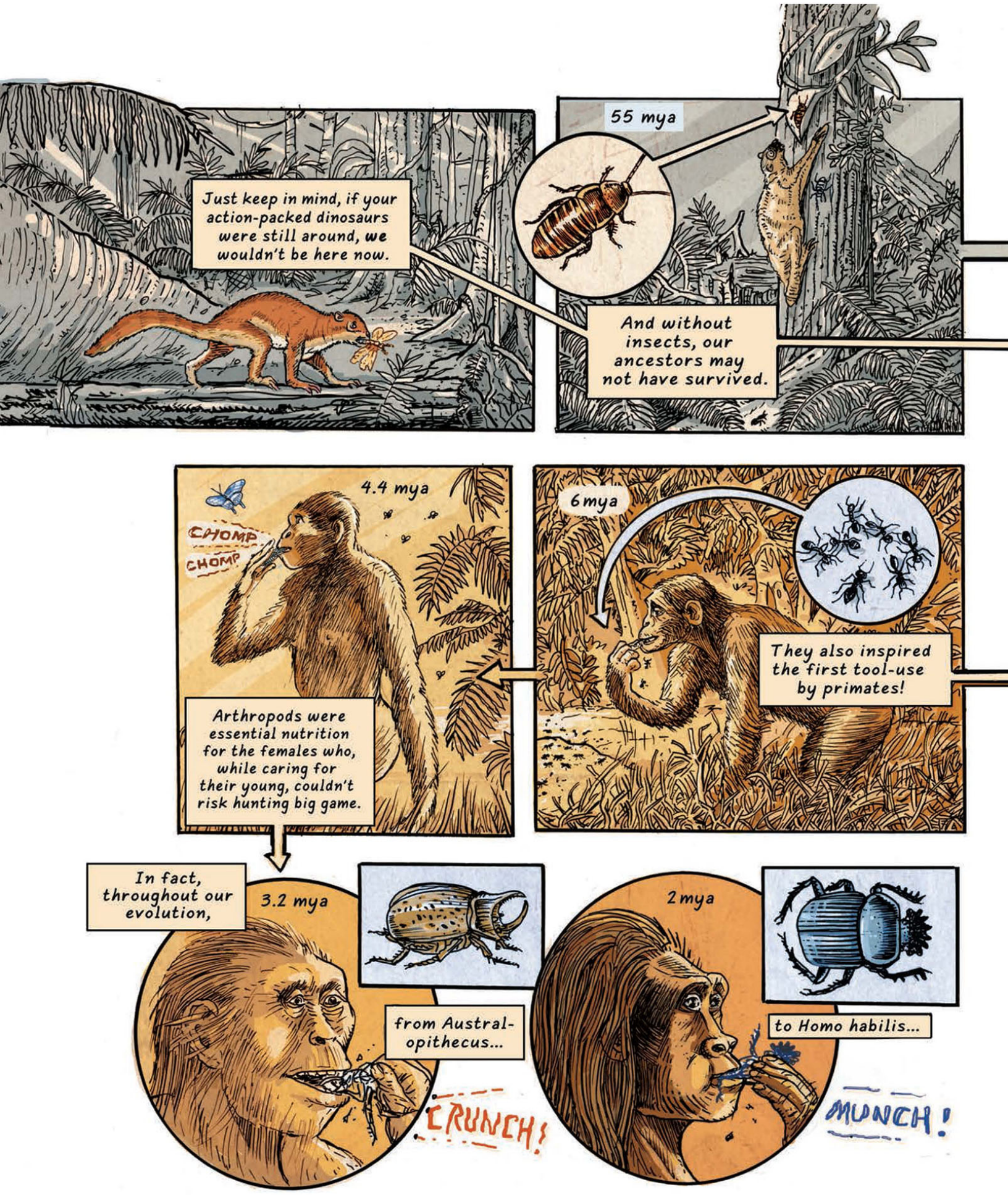


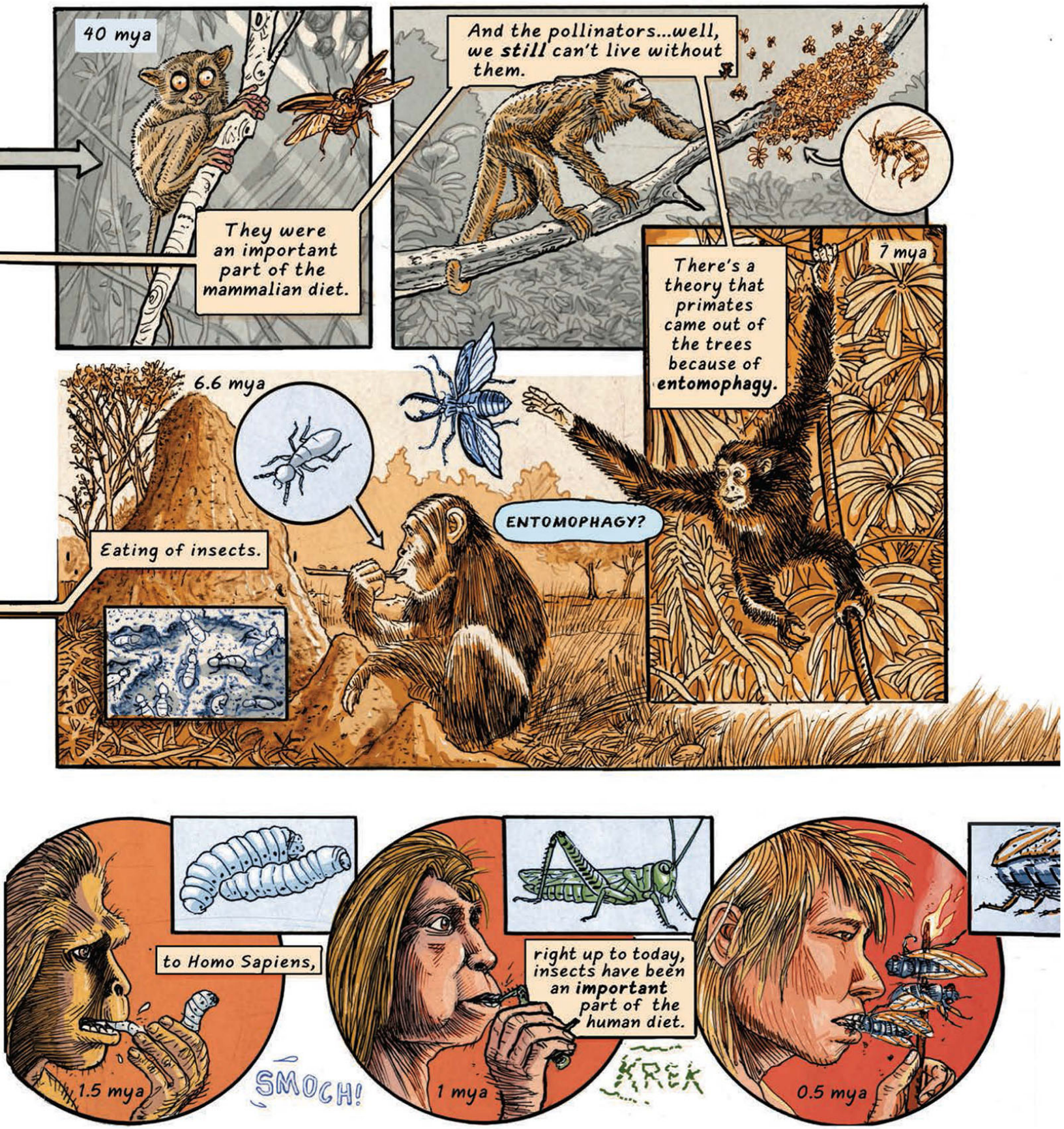

55.8 mya
Yep. And with those predators out of the picture, there was a huge diversification of new genera in the PETM.
CAN YOU SAY THAT IN ENGLISH?
PETM—that's the Paleocene-Eocene Thermal Maximum.
By burning fossil fuels we've increased carbon levels in centuries, not millennia.
SO, WHAT MADE IT COOL DOWN?
I think it was the Azolla Event, a bloom of fresh-water ferns that absorbed carbon from the atmosphere.
BORING. SEE, THERE WAS WAY MORE ACTION WHEN DINOSAURS WERE AROUND!
Okay, how about this? In the Late Eocene there was a seven-foot, three-hundred-pound predator called Diatryma that could claw and peck you to death.
33.9 mya


For reasons we haven't precisely determined, Earth was experiencing an abrupt period of global warming.
NO NORTH POLE?? HOW LONG DID THAT LAST?
The Eocene had three eras. The PETM lasted about 100,000 years.
The polar ice caps DIDN'T EXIST— they were tropical swamps!
The carbon levels were comparable to what's happening today, with one big difference...
Though many species did well, the warming caused mass extinctions, especially in the deep oceans.

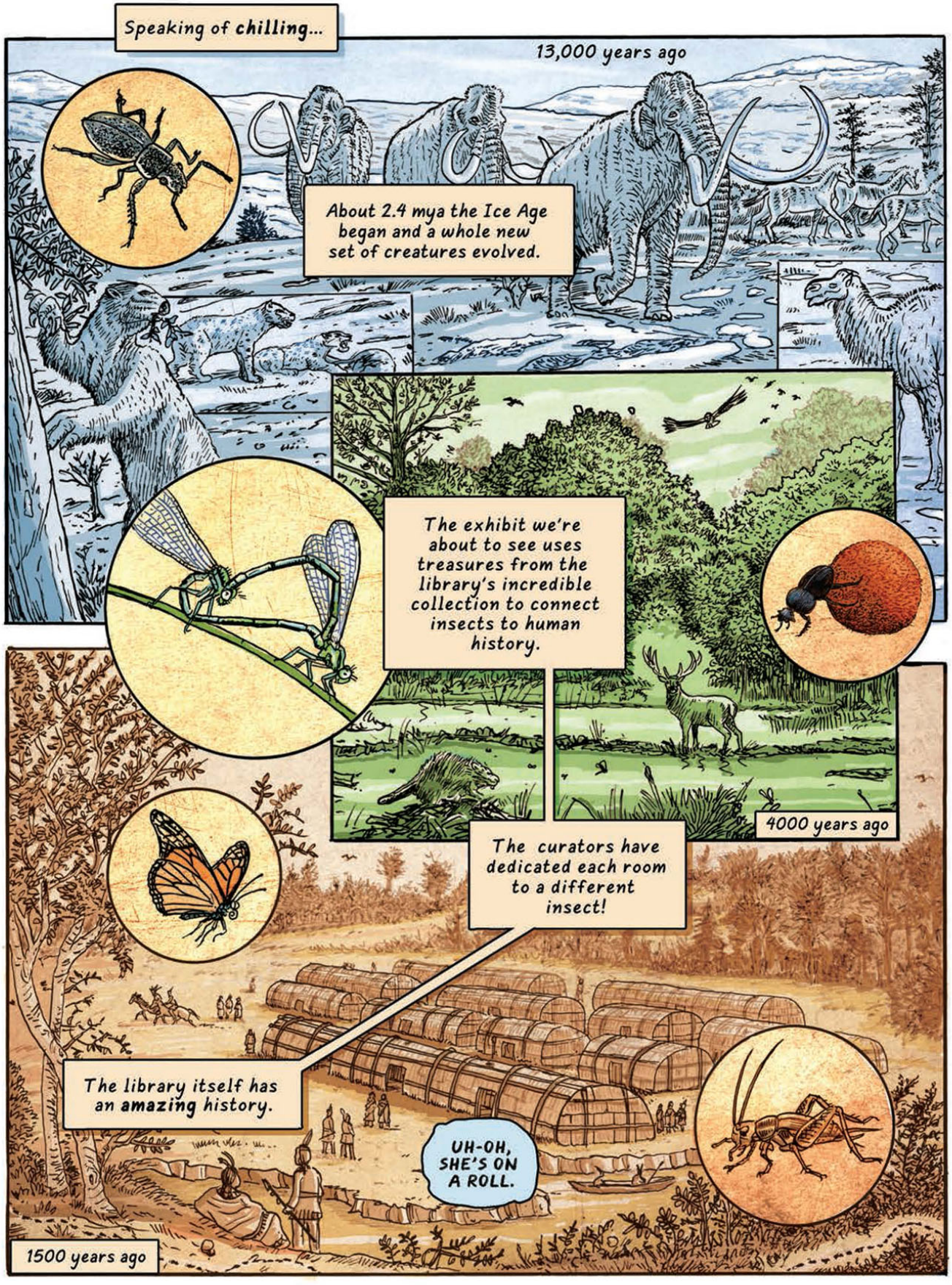

AW, NOW YOU'RE JUST MAKING STUFF UP!
No. It's still a hypothesis, but there's evidence from the azolla found in the Arctic Sea. Of course there were probably other contributing factors.
During the MECO—Middle Eocene Climactic Optimum—the world's cooling introduced new species, and insects thrived.

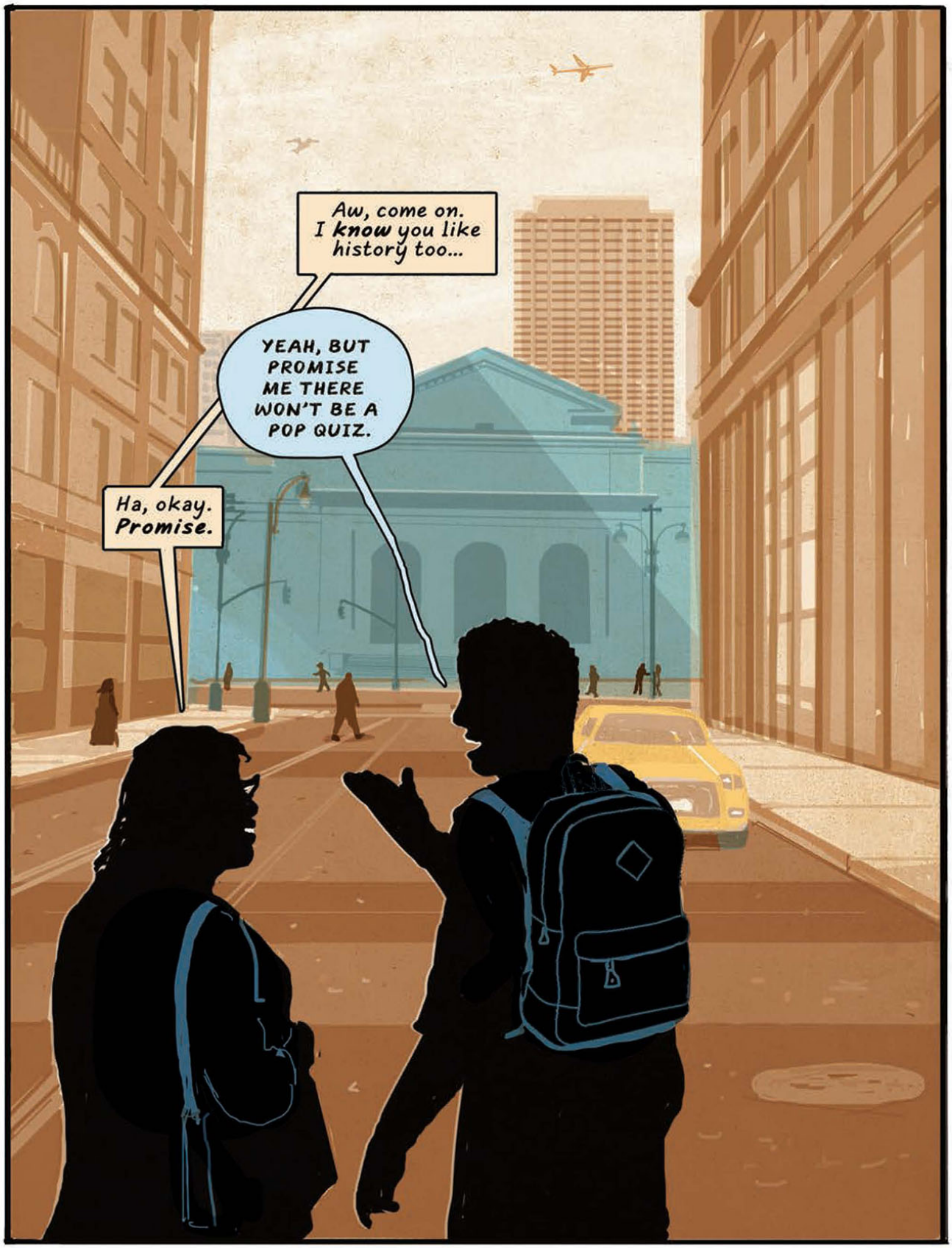

NOW YOU'RE TALKING!
This period was filled with plenty of remarkable creatures. You shouldn't be just stuck on the Cretaceous. The Eocene is loaded with clues about the impact of what we're dealing with today.
MMM, I'D STLL RATHER VISIT JURASSIC PARK.

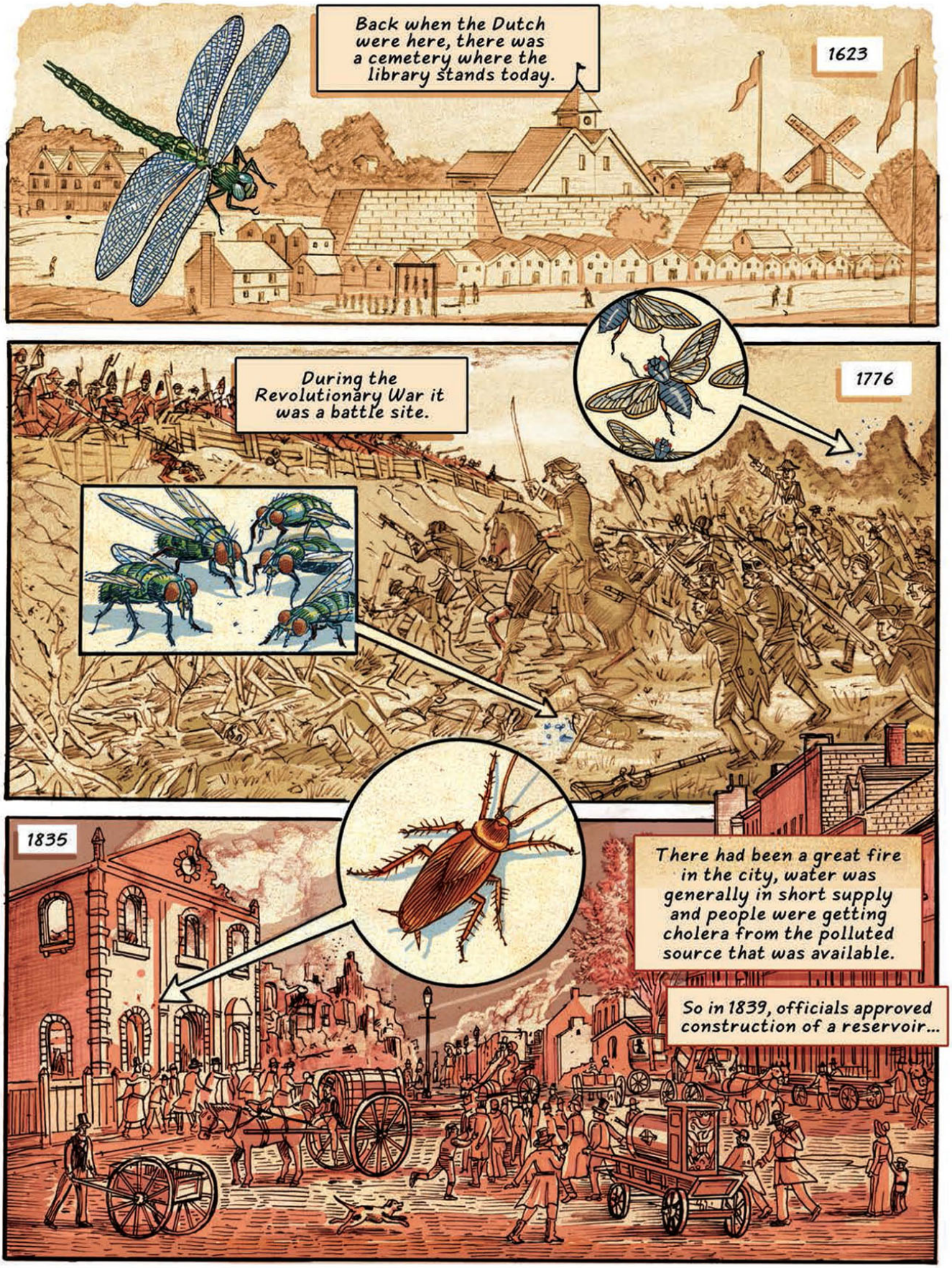

Just keep in mind, if your action-packed dinosaurs were still around, we wouldn't be here now.
55 mya
And without insects, our ancestors may not have survived.
4.4 mya
CHOMP
CHOMP
Arthropods were essential nutrition for the females who, while caring for their young, couldn't risk hunting big game.
6 mya
They also inspired the first tool-use by primates!
In fact, throughout our evolution,
3.2 mya
from Austral-opithecus...
CRUNCH!
2 mya
to Homo habilis...
MUNCH!

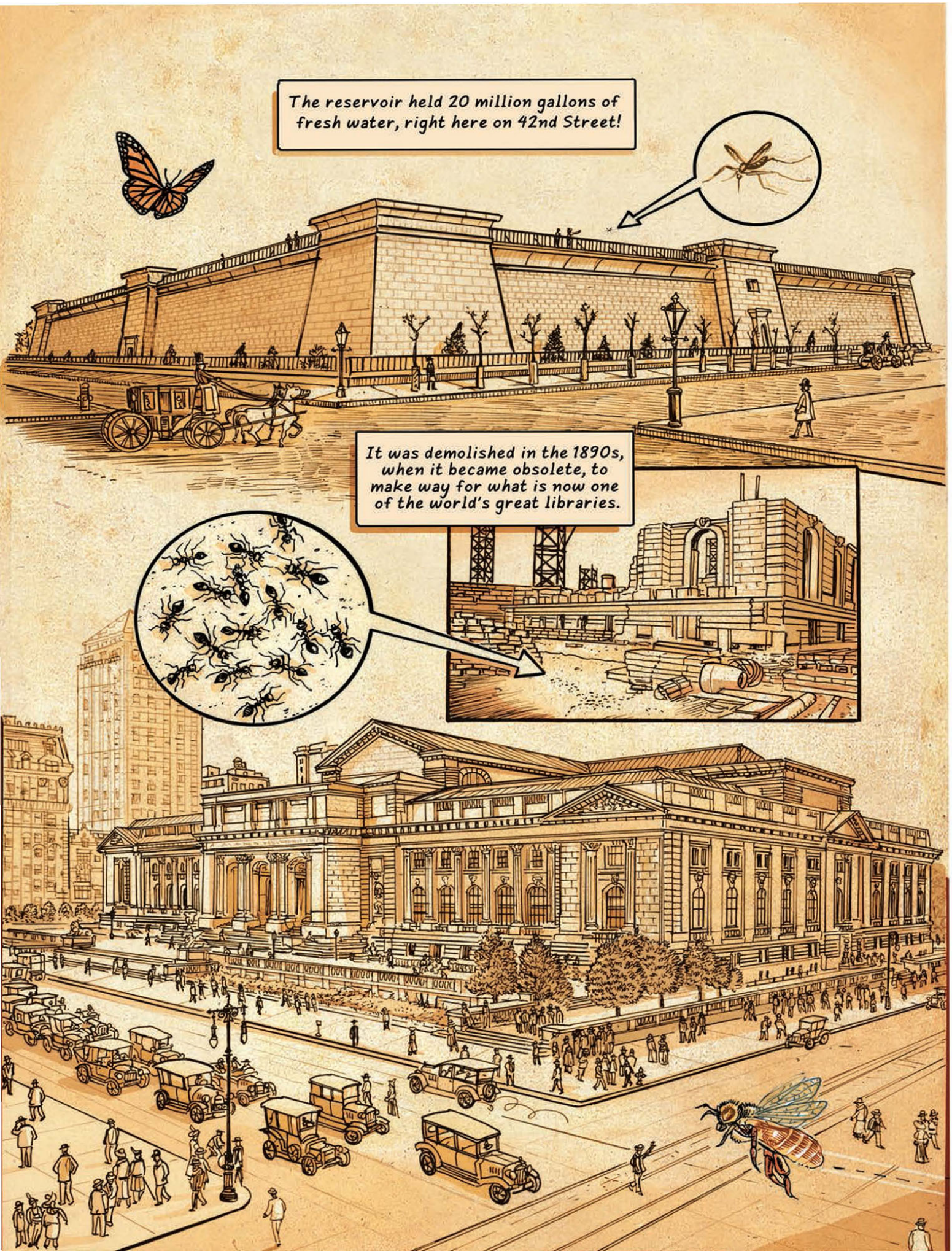

40 mya
They were an important part of the mammalian diet.
And the pollinators...well, we still can't live without them.
7 mya
There's a theory that primates came out of the trees because of entomophagy.
6.6 mya
ENTOMOPHAGY?
Eating of insects.
to Homo Sapiens,
1.5 mya
SMOCH!
right up to today, insects have been an important part of the human diet.
1 mya
KREK
0.5 mya
SCREECH

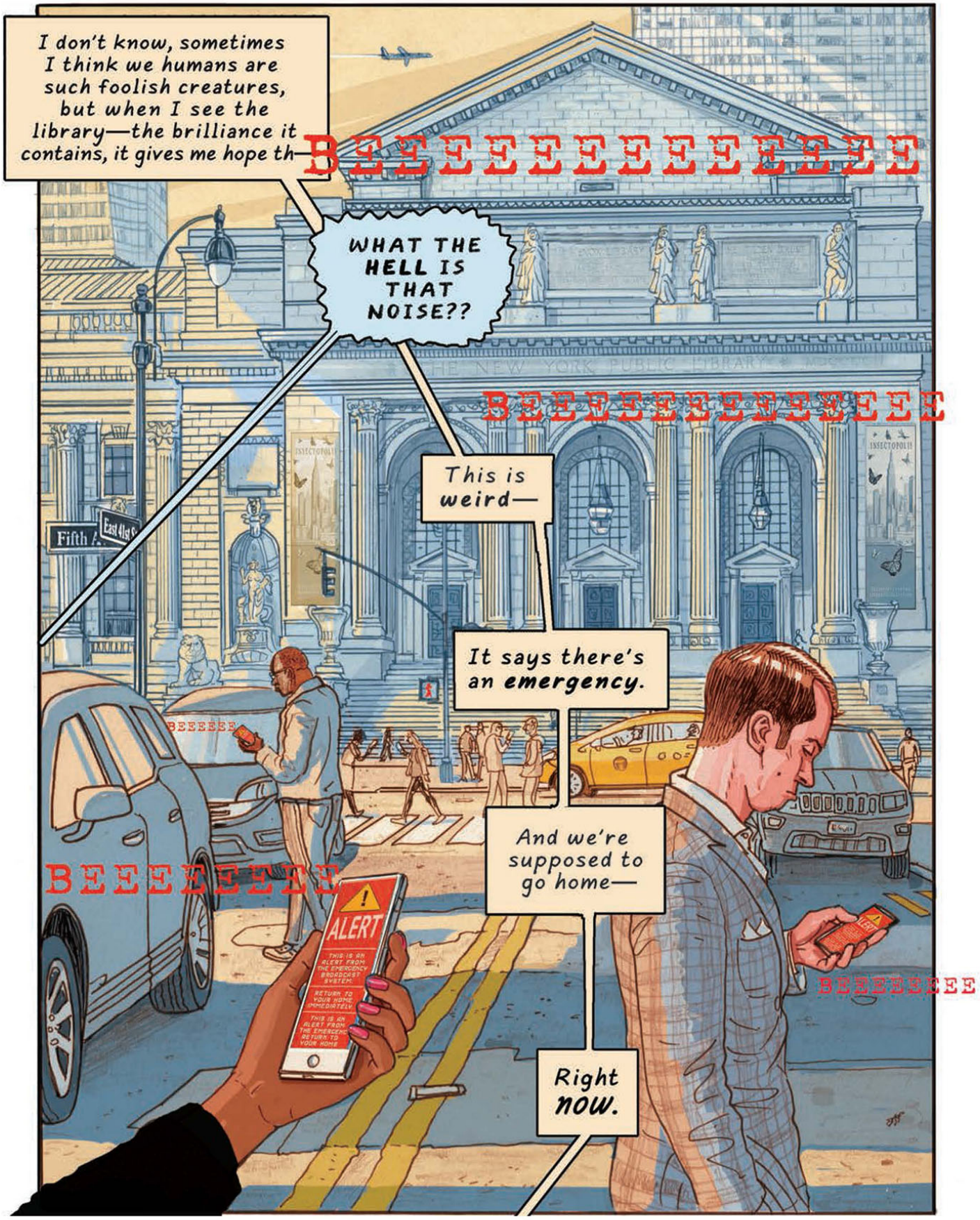
B-BEEP-BEEEP!
Ahhh! Heads up!!
WATCH THE F#%$ OUT!
Let's try not to get killed before we get to the library!
WHOA! THE DRIVERS IN THIS TOWN NEED TO CHILL!
SCREECH


Speaking of **chilling**...
13,000 years ago
About 2.4 mya the Ice Age began and a whole new set of creatures evolved.
The exhibit we're about to see uses treasures from the library's incredible collection to connect insects to human history.
4000 years ago
The curators have dedicated each room to a different insect!
The library itself has an **amazing** history.
UH-OH, SHE'S ON A ROLL.
1500 years ago

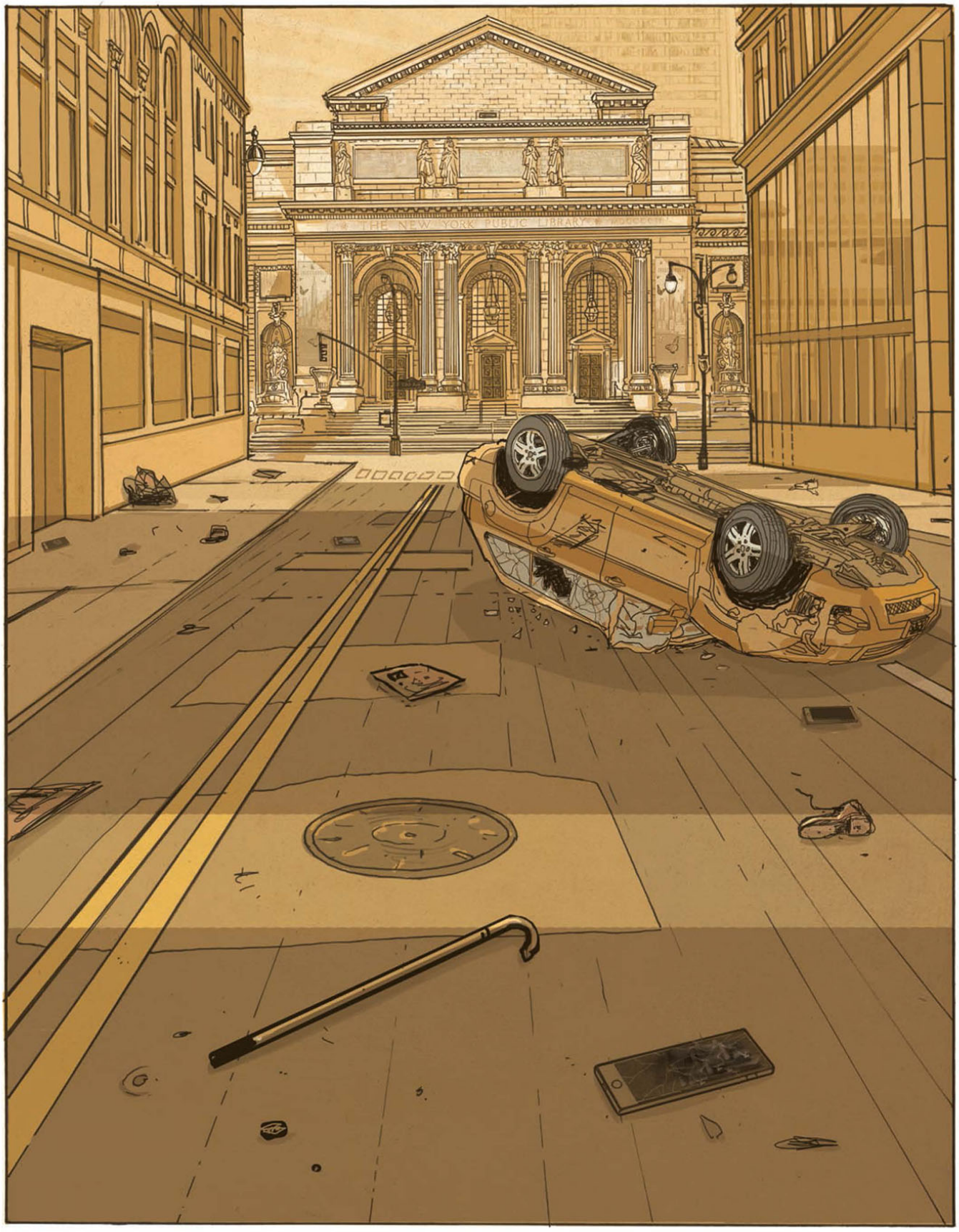

Aw, come on. I know you like history too...
YEAH, BUT PROMISE ME THERE WON'T BE A POP QUIZ.
Ha, okay. Promise.


Back when the Dutch were here, there was a cemetery where the library stands today.
1623
During the Revolutionary War it was a battle site.
1776
1835
There had been a great fire in the city, water was generally in short supply and people were getting cholera from the polluted source that was available.
So in 1839, officials approved construction of a reservoir...


The reservoir held 20 million gallons of fresh water, right here on 42nd Street!
It was demolished in the 1890s, when it became obsolete, to make way for what is now one of the world's great libraries.


I don't know, sometimes I think we humans are such foolish creatures, but when I see the library—the brilliance it contains, it gives me hope th—
BEEEEEEEEEEEEEE
WHAT THE HELL IS THAT NOISE??
BEEEEEEEEEEEEEEEE
This is weird—
It says there's an emergency.
BEEEEEEE
BEEEEEEEEE
And we're supposed to go home—
ALERT
THIS IS AN ALERT FROM THE EMERGENCY BROADCAST SYSTEM.
RETURN TO YOUR HOME IMMEDIATELY.
THIS IS AN ALERT FROM THE EMERGENCY RETURN TO YOUR HOME
BEEEEEEEE
Right now.

One week later.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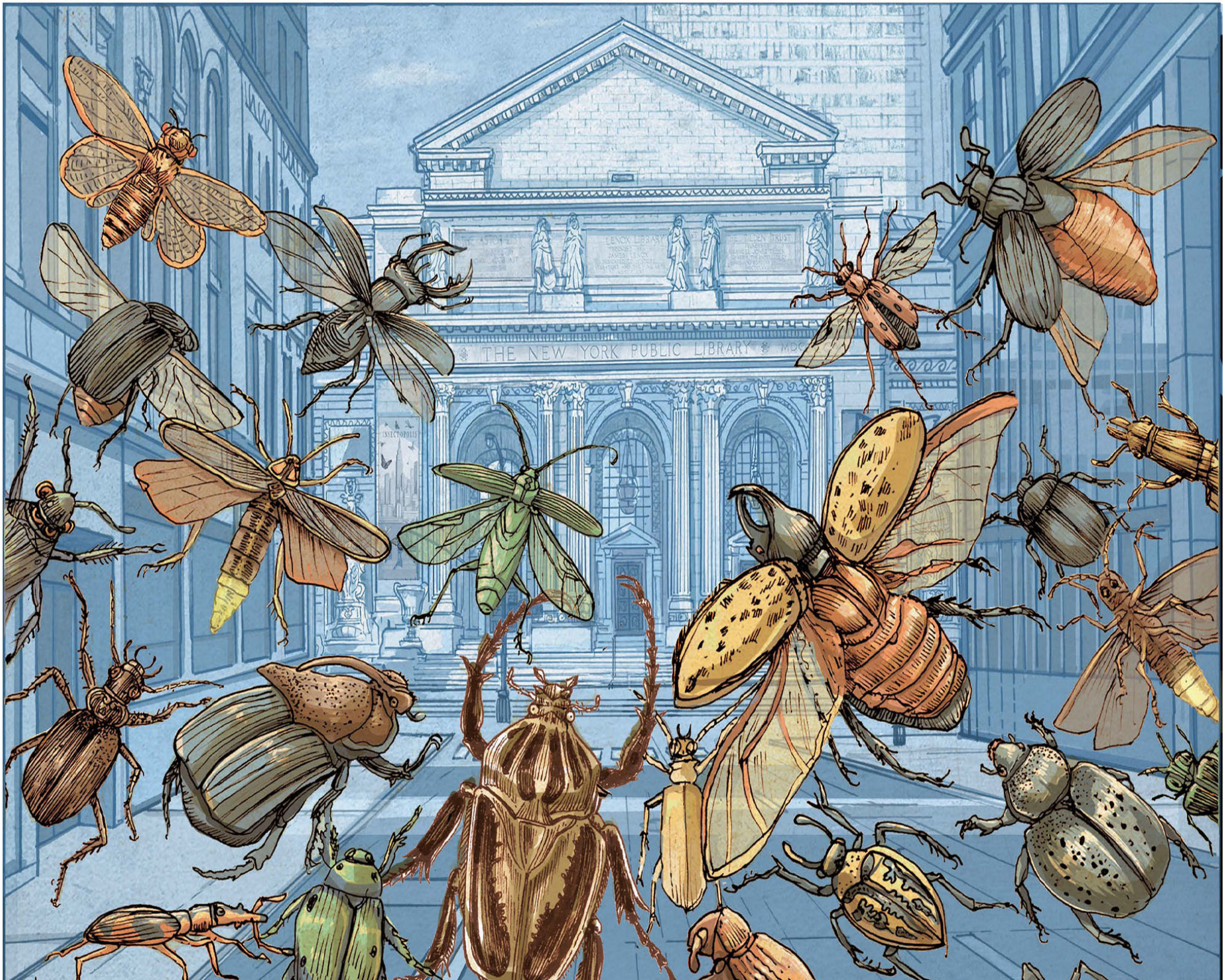
Much (much) later.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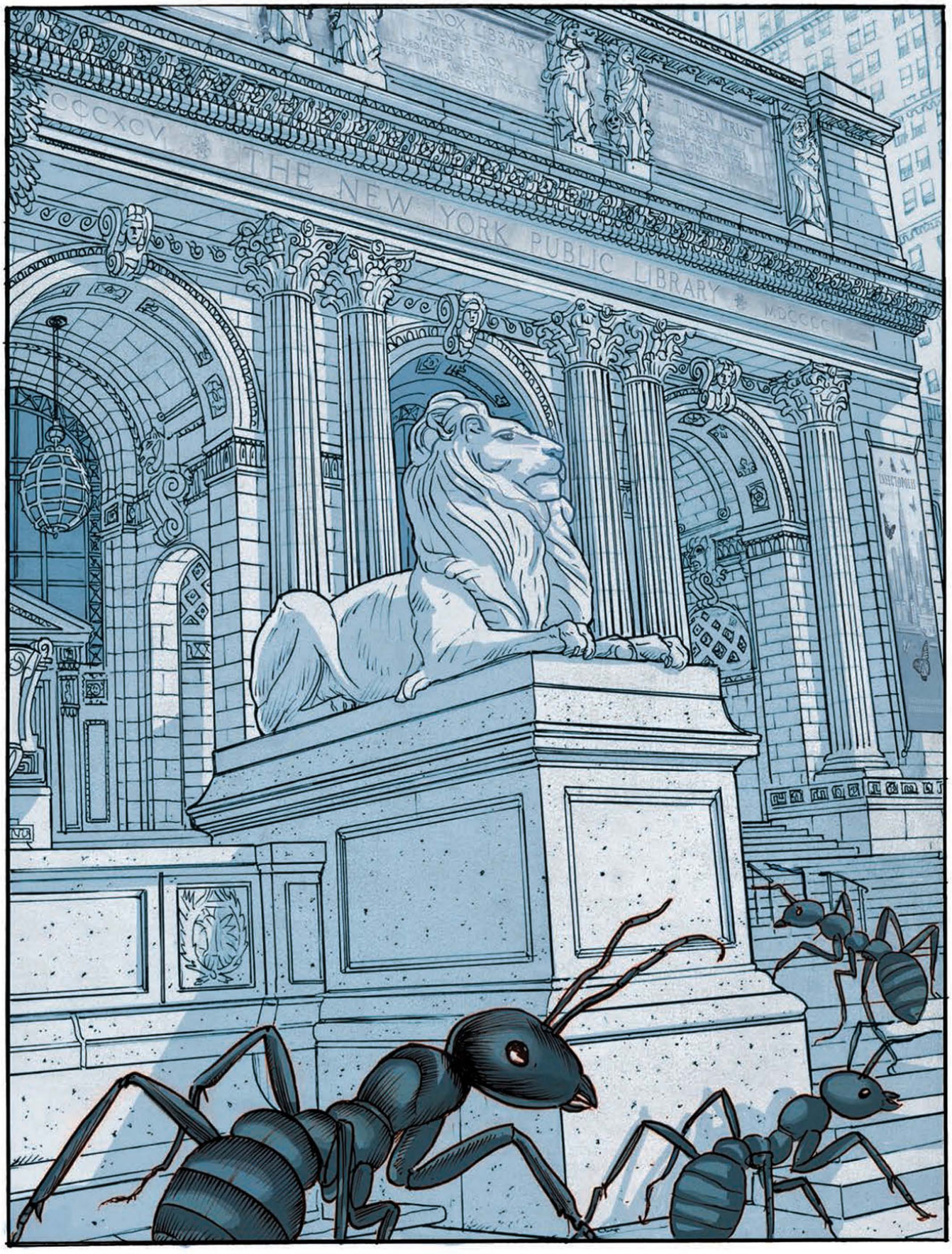
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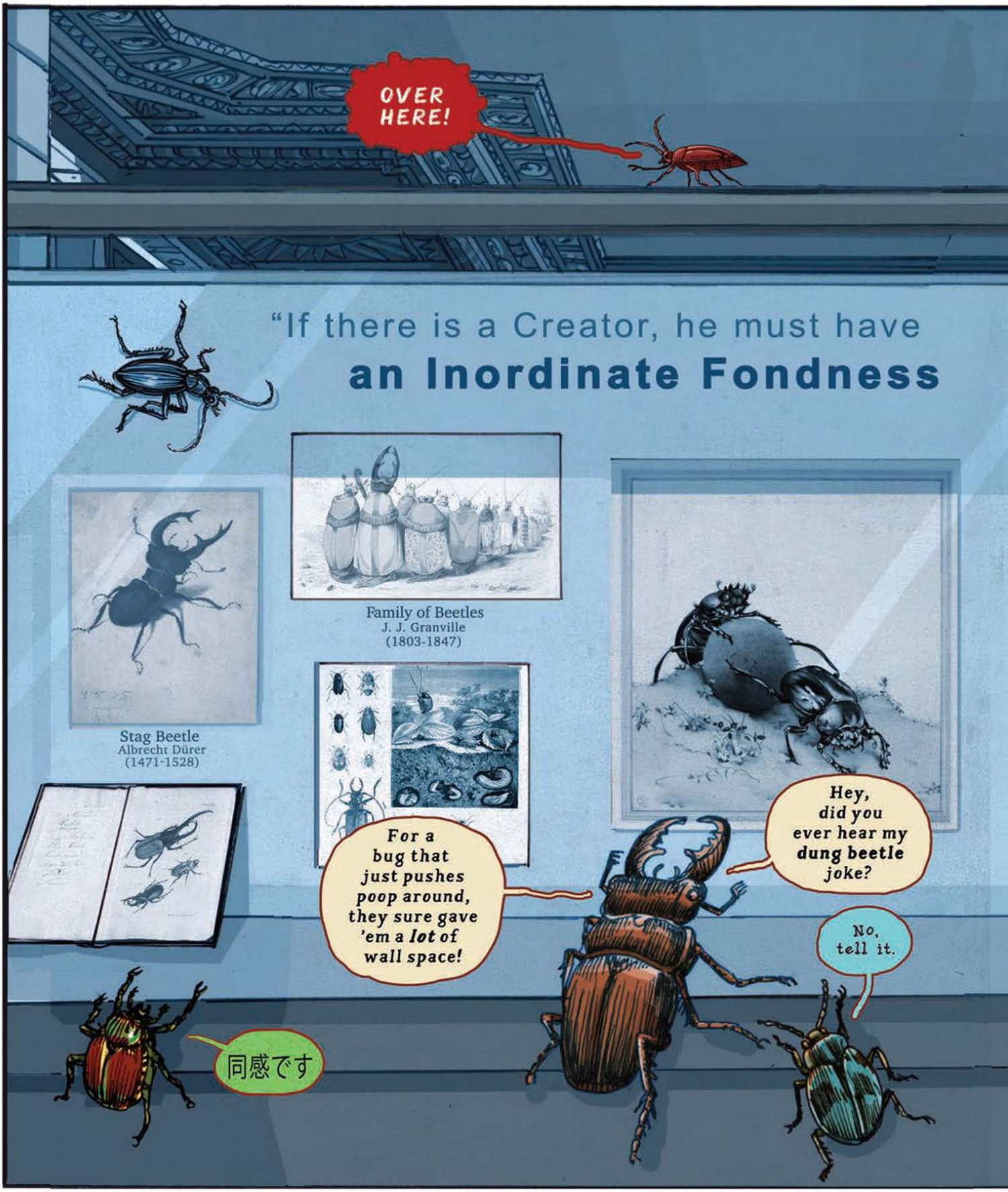
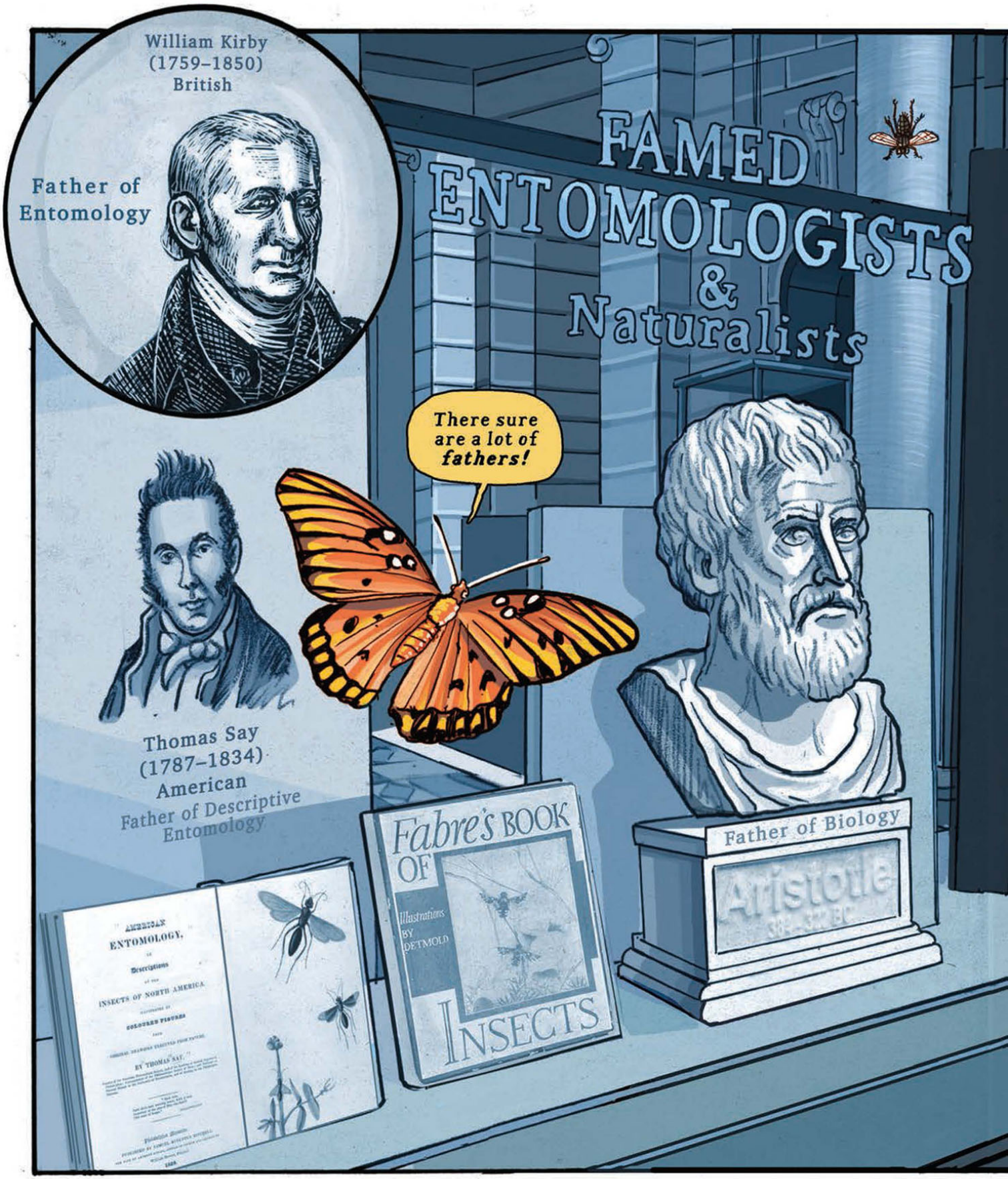
INSECTOPOLIS

INSECTOPOLIS
TREASURES FROM THE LIBRARY'S COLLECTION
MARIA SIBYLLA MERIAN
Wow! An entire library filled with exhibits about us!
'Bout time!

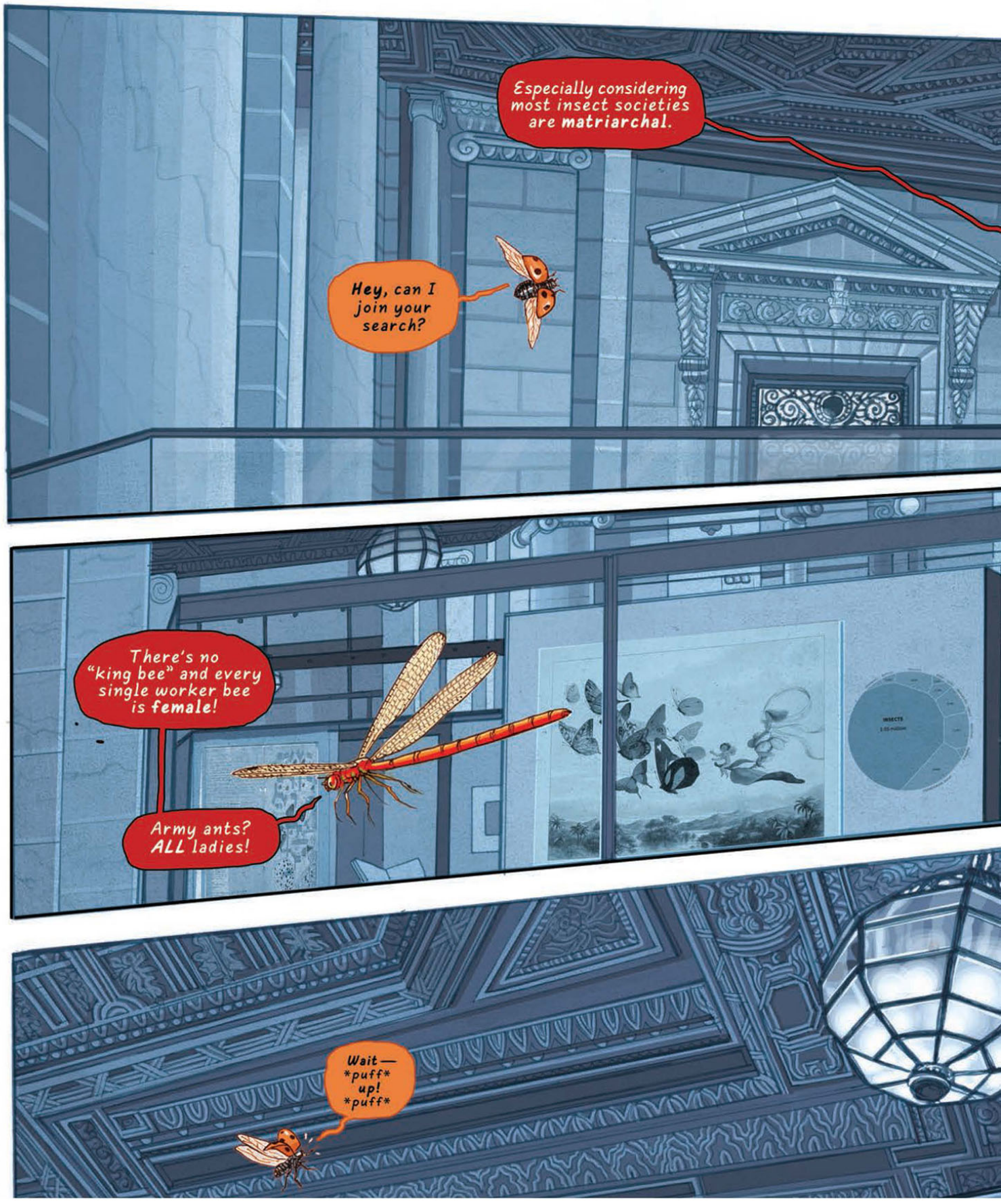
The architecture is remarkable!
Anybody seen any flowers?
Mommy?
T-this is s-s-s-so c-cool!
Where's the beetle display??
INSECTO
SIVE
Minimorum Anim
THEATRVM
Olim ab
EDOARDO WOTTONO,
CONRADO GESNERO,
THOMASVE PENNIO
inchoatum:
Tandem
INSECTOPO
TREASURES F
LIBRARY'S CO
Three-fourths of the world's flowering plants and about 35 percent of the world's food crops depend on insect pollinators.

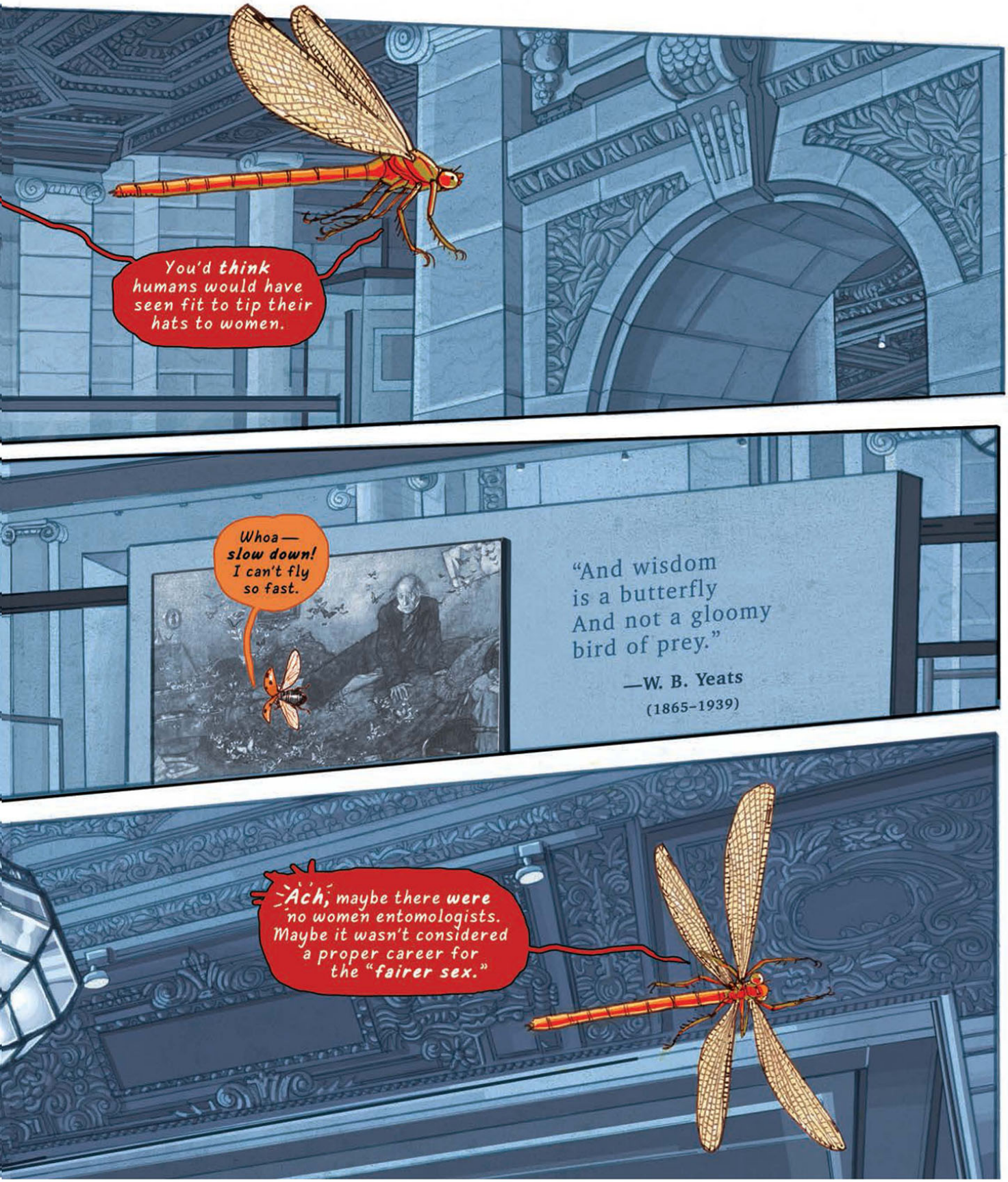

OVER HERE!
"If there is a Creator, he must have
an Inordinate Fondness
Family of Beetles
J. J. Granville
(1803-1847)
Stag Beetle
Albrecht Dürer
(1471-1528)
For a bug that just pushes poop around, they sure gave 'em a lot of wall space!
Hey, did you ever hear my dung beetle joke?
No, tell it.
同感です

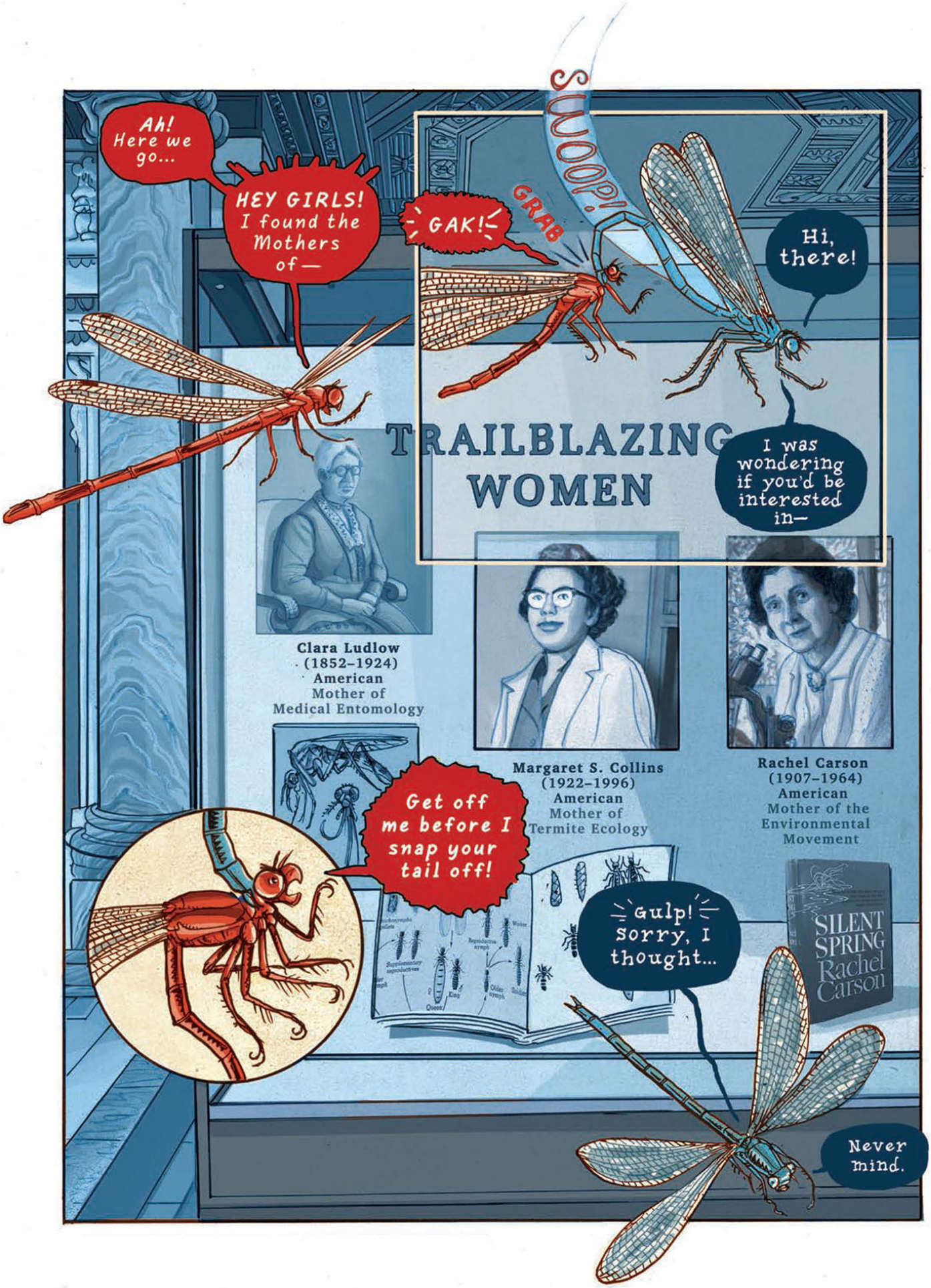
for Beetles"
—J. B. S. Haldane
(1892–1964)
Wait, here comes one—
Let's hide from him!
FABRE'S BOOK OF INSECTS
Illustrations by DETMOLD
" I am dying by inches from not having any body to talk to about insects."
–Charles Darwin
1828
DARWIN & his HOBBY
Charles Darwin as drawn by a classmate
I'd swear I heard some beetles talking...
Fellas?
"If there is a Creator, he must have an Inordinate Fondness for Beetles"
Stag Beetle
Albrecht Dürer
(1471–1528)
Can anyone point me to the toilet?
Tee-hee!


William Kirby
(1759–1850)
British
Father of Entomology
FAMED ENTOMOLOGISTS & Naturalists
There sure are a lot of fathers!
Thomas Say
(1787–1834)
American
Father of Descriptive Entomology
Father of Biology
Aristotle
AMERICAN ENTOMOLOGY,
Descriptions
INSECTS OF NORTH AMERICA
COLOURED FIGURES
BY THOMAS SAY.
Fabre's BOOK OF
Illustrations BY DETMOLD
INSECTS

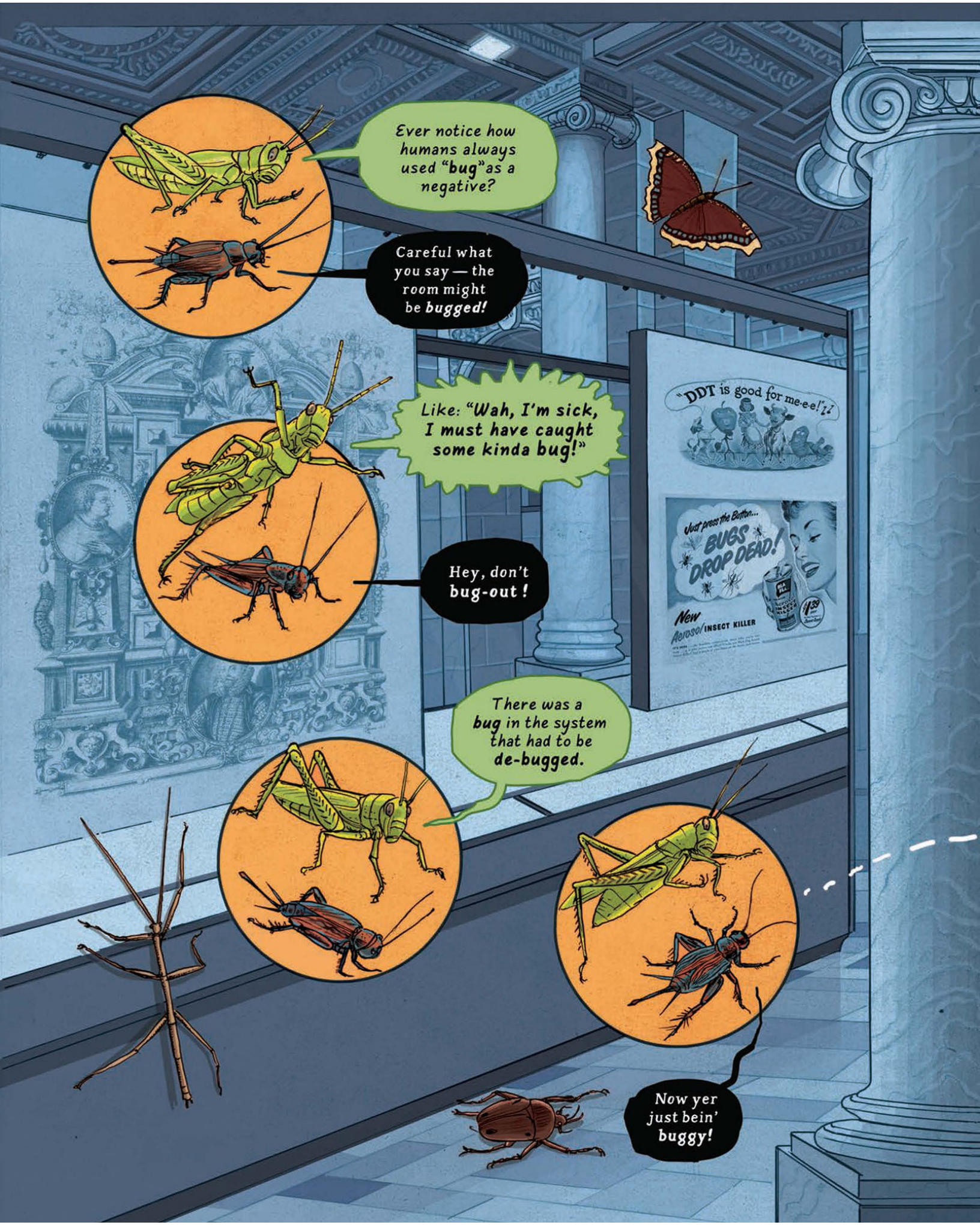
Jean Henri Fabre (1823–1915) French
Father of Modern Entomology
JAN SWAMMERDAM
Carl Linnaeus (1707–1778) Swedish
Father of Modern Taxonomy
Thaddeus William Harris (1795–1856) American
Father of Economic Entomology
Antonie van Leeuwenhoek (1632–1723) Dutch
Father of Microbiology
Yeah! What about the mothers?
Maybe the next display case has some damsels...
There certainly should be!
Jan Swammerdam (1637–1680) Dutch
pioneered the use of the microscope for zoological purposes, and is considered a founder of both comparative anatomy and entomology.
Leeuwenhoek Microscope (circa late 1600s)

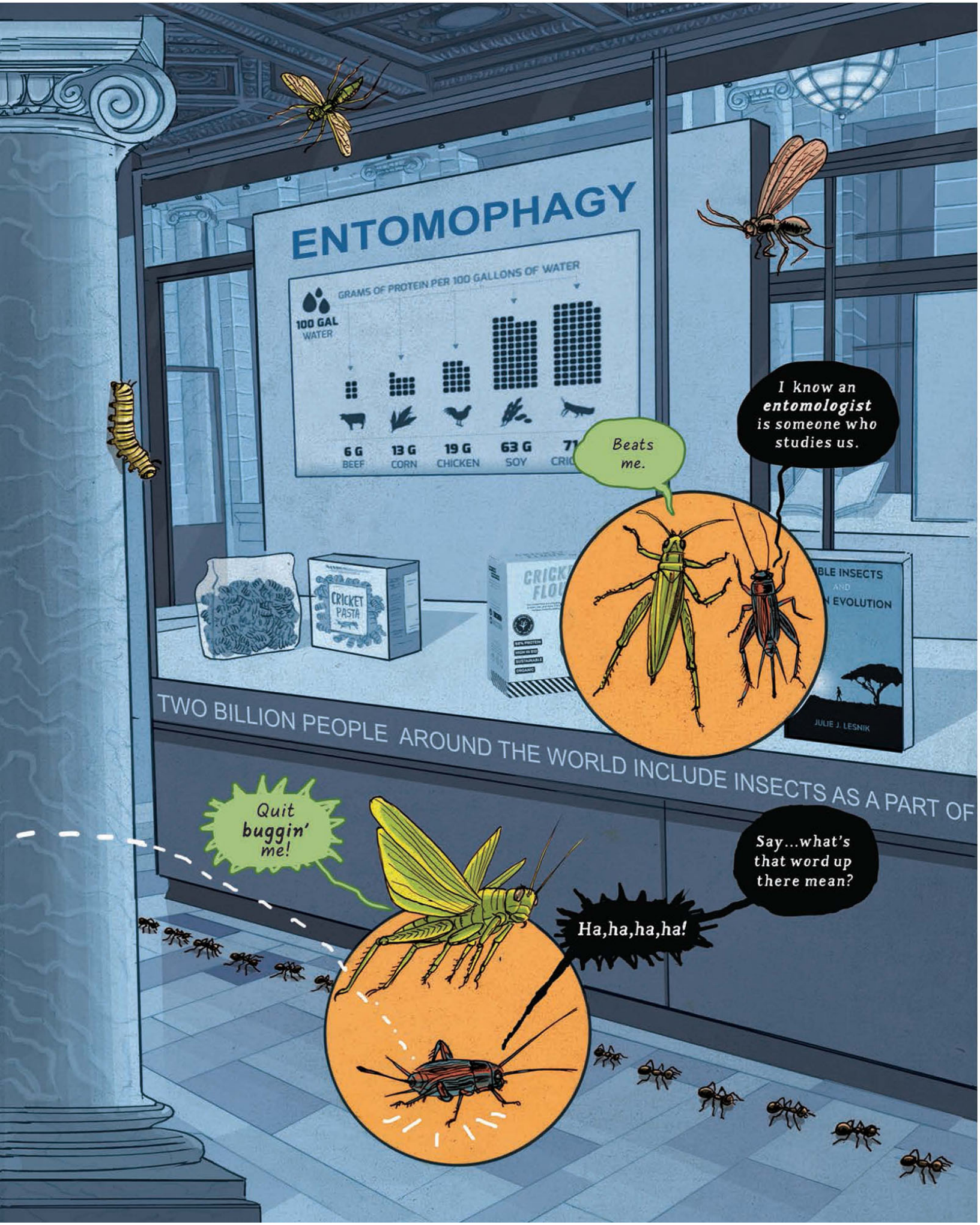

Especially considering most insect societies are **matriarchal.**
Hey, can I join your search?
There's no "king bee" and every single worker bee is **female!**
Army ants? **ALL** ladies!
Wait— *puff* up! *puff*

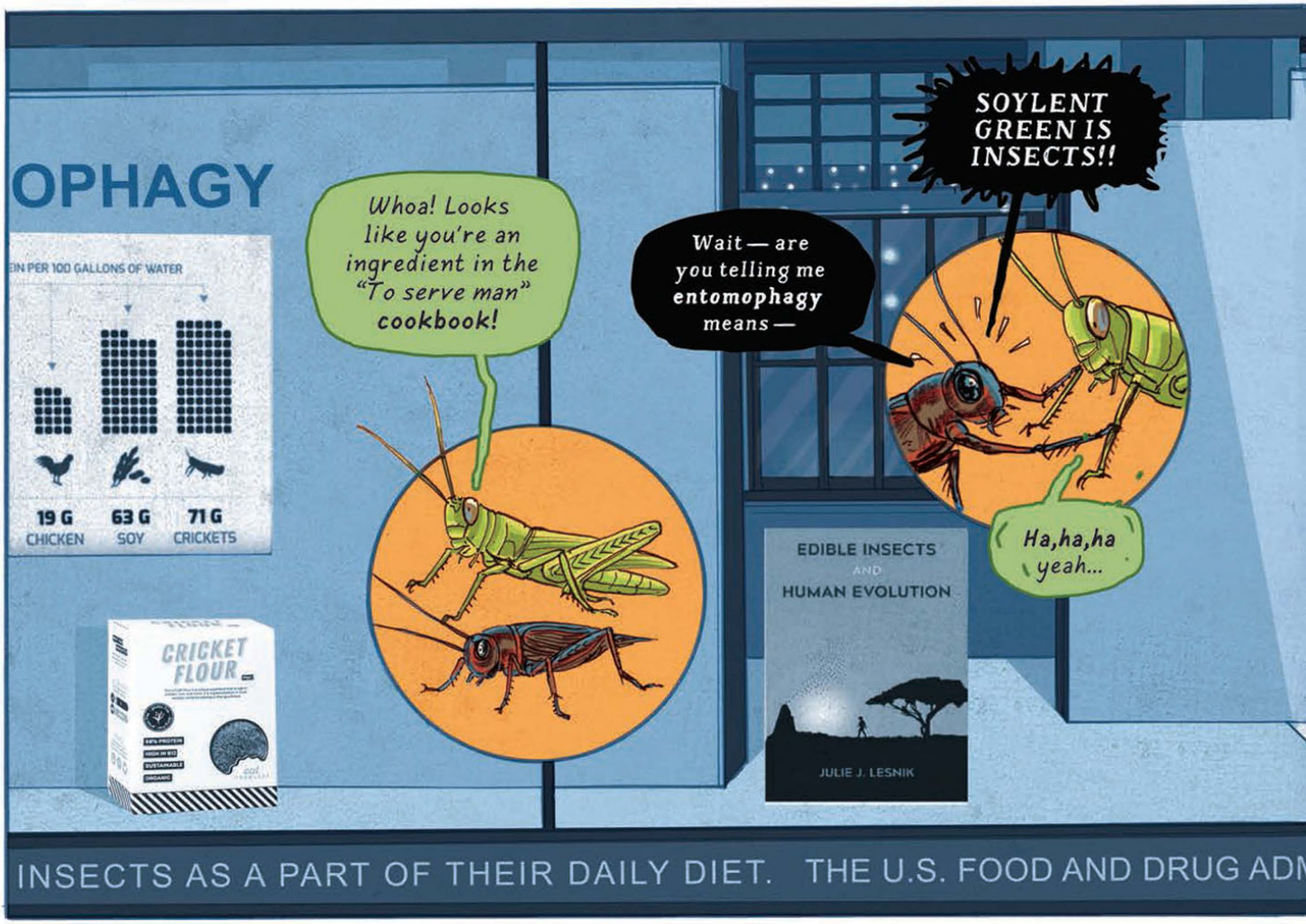

You'd think humans would have seen fit to tip their hats to women.
Whoa— slow down! I can't fly so fast.
"And wisdom is a butterfly And not a gloomy bird of prey."
—W. B. Yeats
(1865–1939)
Ach, maybe there were no women entomologists. Maybe it wasn't considered a proper career for the "fairer sex."

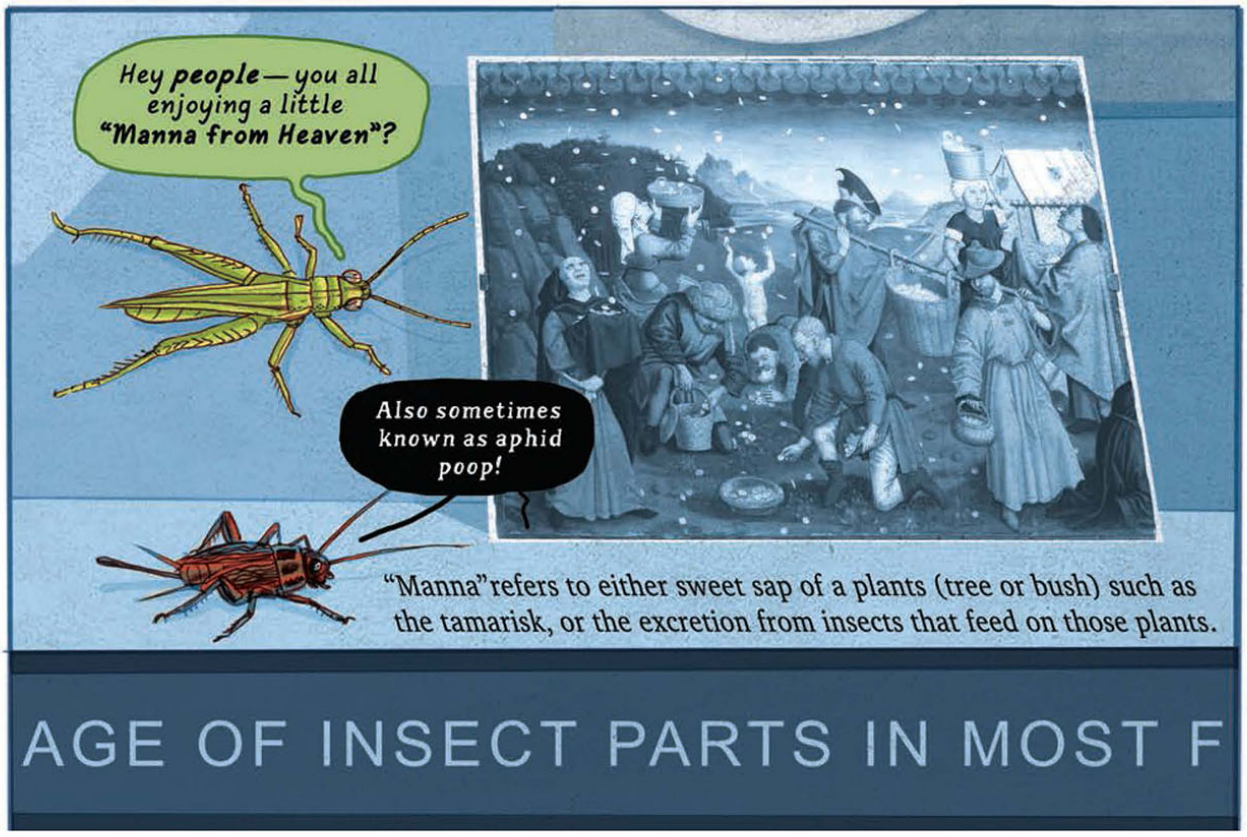

Ah! Here we go...
HEY GIRLS! I found the Mothers of—
SWOOP!
GRAB
GAK!
Hi, there!
I was wondering if you'd be interested in—
TRAILBLAZING WOMEN
Clara Ludlow
(1852–1924)
American
Mother of Medical Entomology
Margaret S. Collins
(1922–1996)
American
Mother of Termite Ecology
Rachel Carson
(1907–1964)
American
Mother of the Environmental Movement
Get off me before I snap your tail off!
Gulp! Sorry, I thought...
SILENT SPRING
Rachel Carson
Never mind.

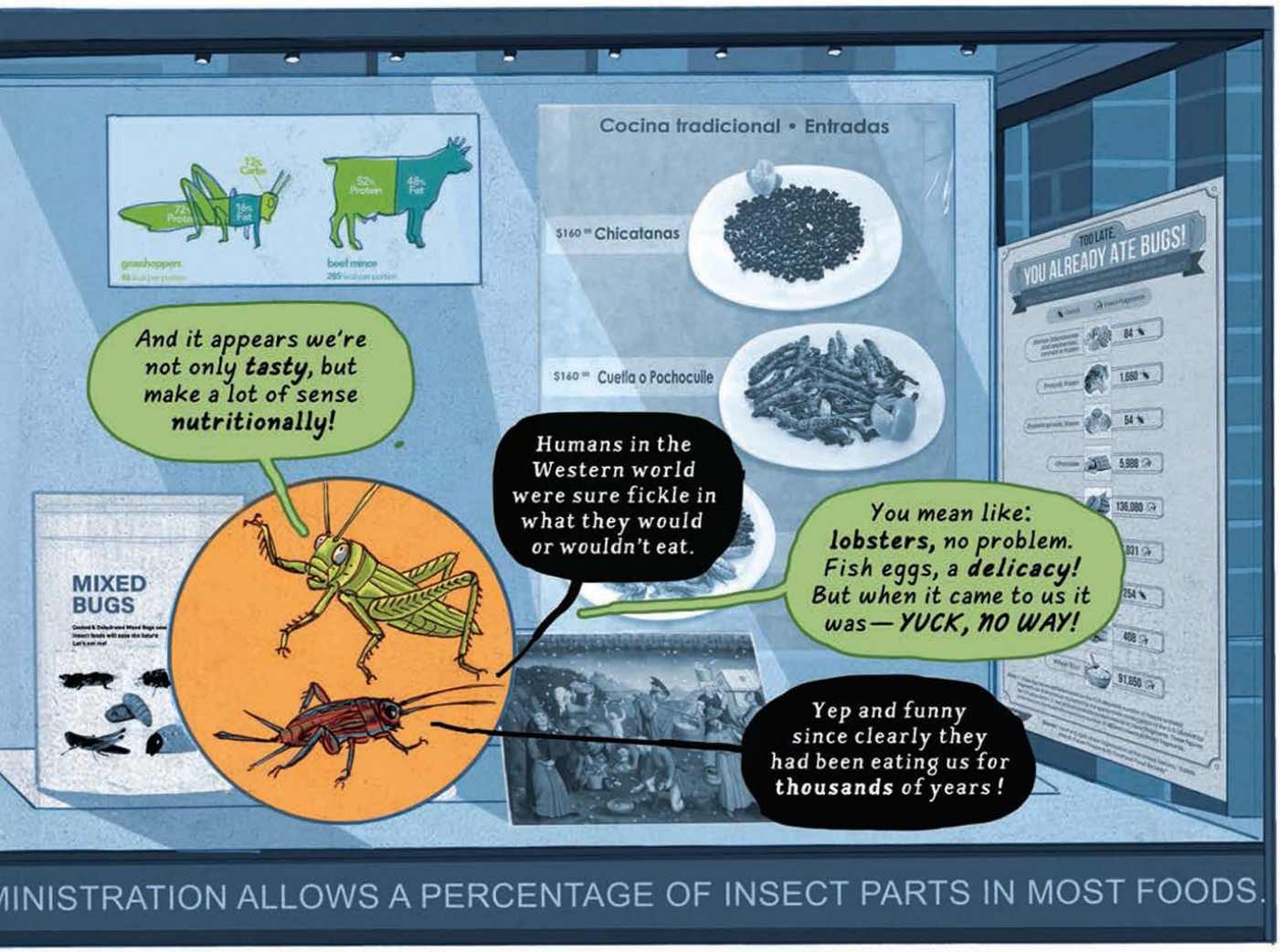
That's more like it! I want to know more about her.
It says there are even more exhibits upstairs.
Mother of Entomology
Eleanor Ormerod (1828–1901) American Mother of Agricultural Entomology
Anna Comstock (1864-1930) American Pioneering Insect Illustrator and Author
Miriam Rothschild (1908-2005) British
Maria Sibylla Merian (1647-1717)
Mary Talbot (1903–1990) American Mother of Myrmecology (the study of ants)
Handbook of NATURE STUDY
Hold up girls— I want to read this.
Let's check out the next display.
Lead on!

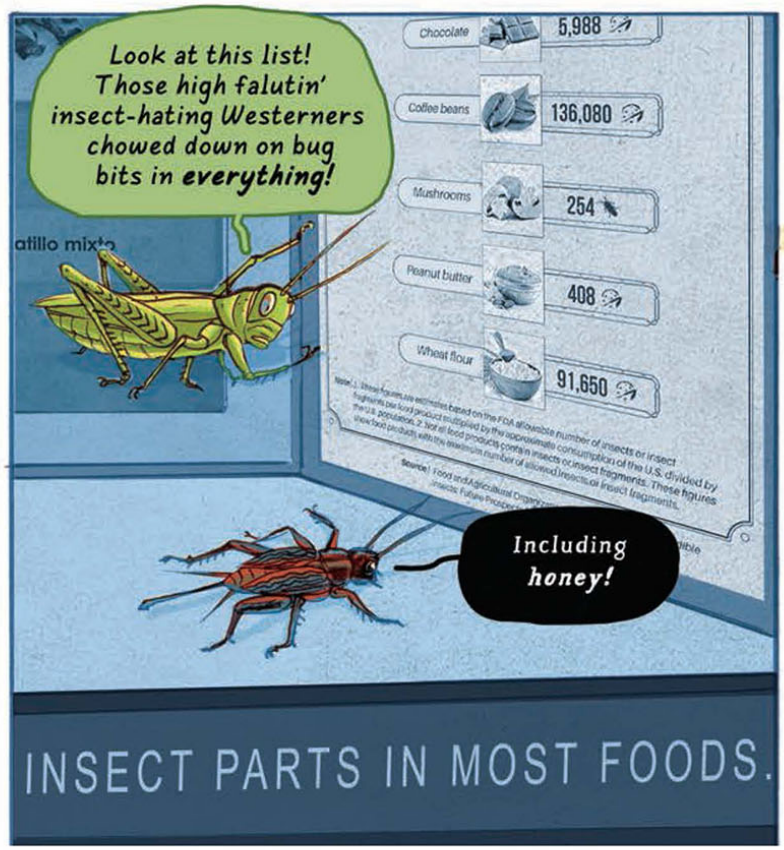

Ever notice how humans always used "bug" as a negative?
Careful what you say — the room might be bugged!
Like: "Wah, I'm sick, I must have caught some kinda bug!"
Hey, don't bug-out!
There was a bug in the system that had to be de-bugged.
Now yer just bein' buggy!
"DDT is good for me-e-e!"
Just press the Button...
BUGS DROP DEAD!
New Aeroso INSECT KILLER

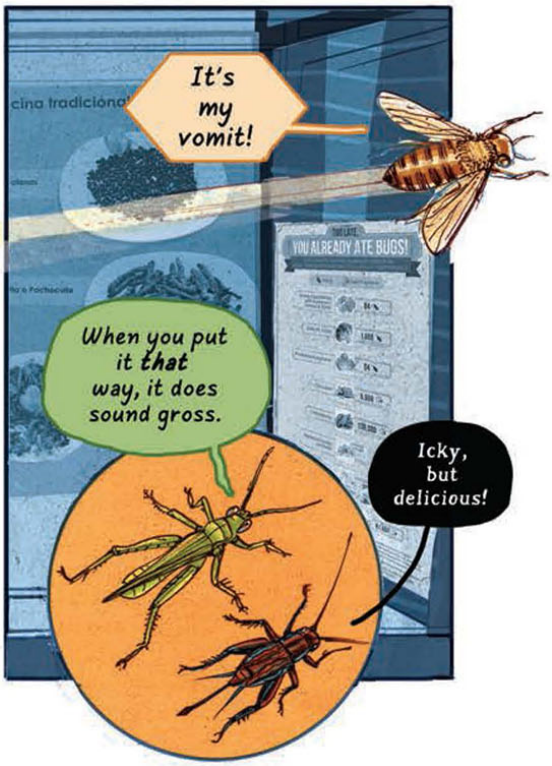

ENTOMOPHAGY
GRAMS OF PROTEIN PER 100 GALLONS OF WATER
100 GAL WATER
6 G BEEF
13 G CORN
19 G CHICKEN
63 G SOY
CRICKET PASTA
I know an entomologist is someone who studies us.
Beats me.
JULIE J. LESNIK
TWO BILLION PEOPLE AROUND THE WORLD INCLUDE INSECTS AS A PART OF
Quit buggin' me!
Say...what's that word up there mean?
Ha,ha,ha,ha!

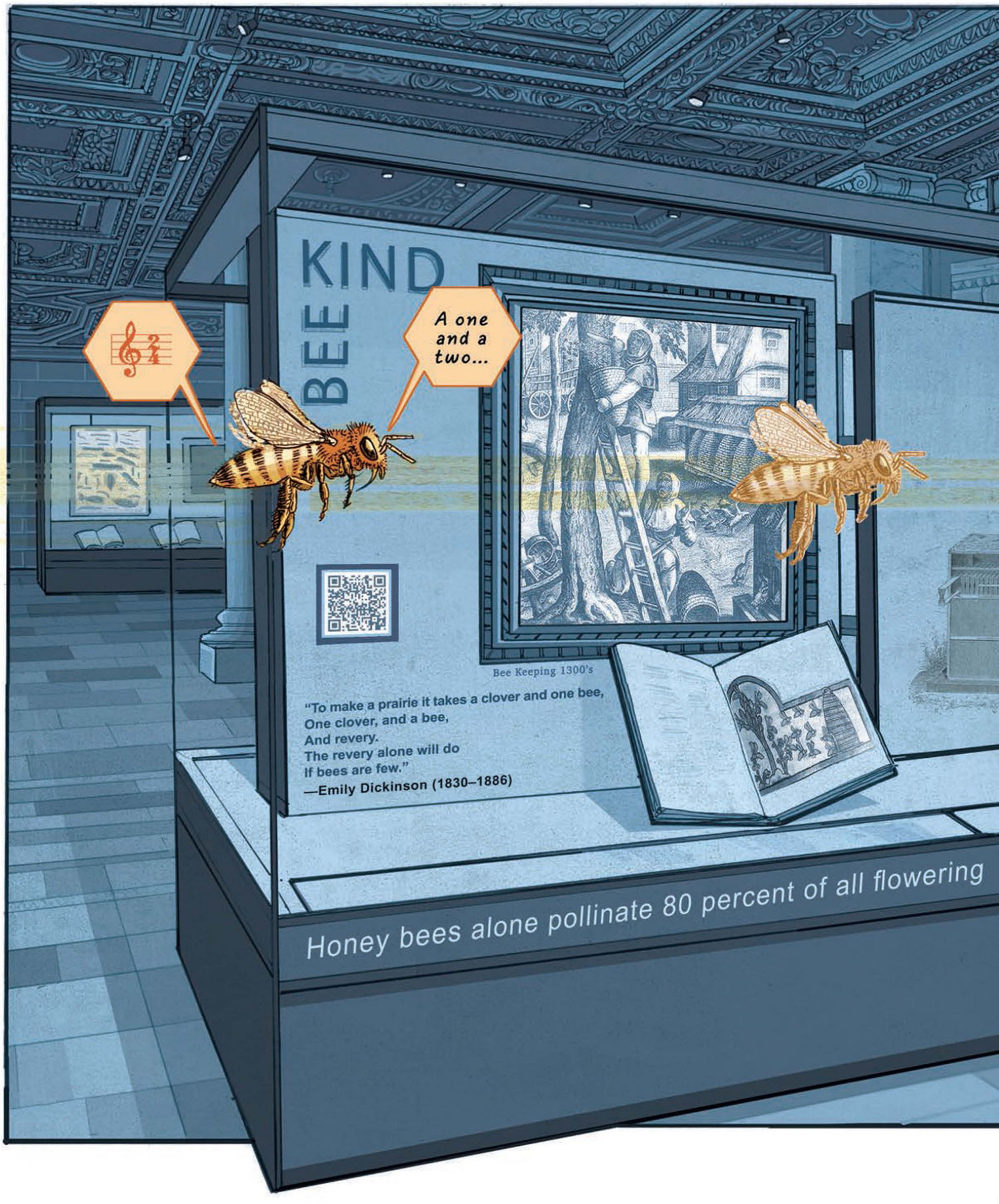

OPHAGY
IN PER 100 GALLONS OF WATER
19 G
CHICKEN
63 G
SOY
71 G
CRICKETS
CRICKET FLOUR
Whoa! Looks like you're an ingredient in the "To serve man" cookbook!
Wait — are you telling me entomophagy means —
SOYLENT GREEN IS INSECTS!!
Ha,ha,ha yeah...
EDIBLE INSECTS AND HUMAN EVOLUTION
JULIE J. LESNIK
INSECTS AS A PART OF THEIR DAILY DIET. THE U.S. FOOD AND DRUG ADM


Hey people — you all enjoying a little "Manna from Heaven"?
Also sometimes known as aphid poop!
"Manna" refers to either sweet sap of a plants (tree or bush) such as the tamarisk, or the excretion from insects that feed on those plants.
AGE OF INSECT PARTS IN MOST F

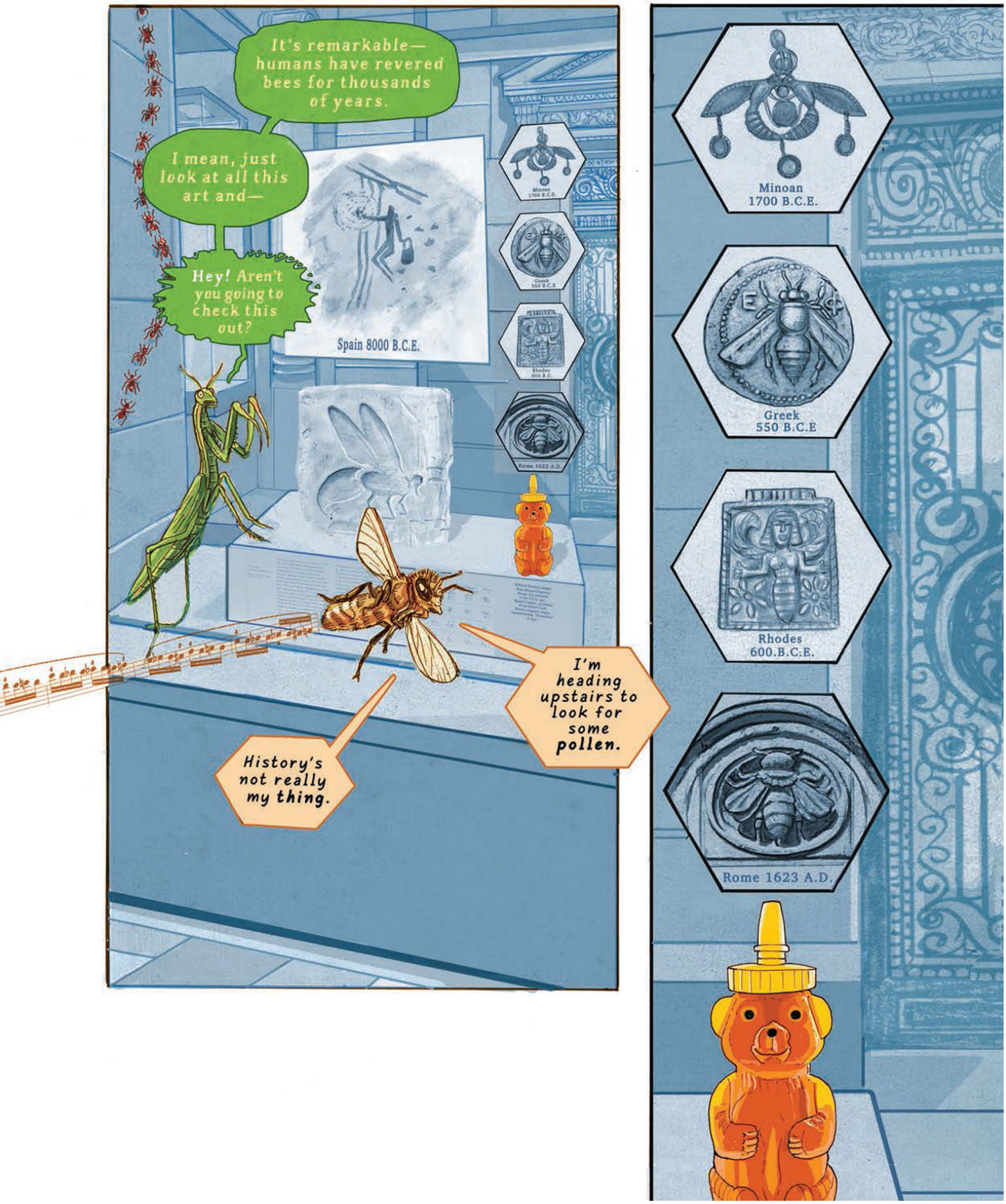

grasshoppers
beef mince
Cocina tradicional • Entradas
$160 MX Chicatanas
$160 MX Cuetla o Pochoculle
MIXED BUGS
TOO LATE.
YOU ALREADY ATE BUGS!
And it appears we're not only tasty, but make a lot of sense nutritionally!
Humans in the Western world were sure fickle in what they would or wouldn't eat.
You mean like: lobsters, no problem. Fish eggs, a delicacy! But when it came to us it was—YUCK, NO WAY!
Yep and funny since clearly they had been eating us for thousands of years!
MINISTRATION ALLOWS A PERCENTAGE OF INSECT PARTS IN MOST FOODS.


Look at this list! Those high falutin' insect-hating Westerners chowed down on bug bits in everything!
Chocolate 5,988
Coffee beans 136,080
Mushrooms 254
Peanut butter 408
Wheat flour 91,650
Including honey!
INSECT PARTS IN MOST FOODS.


It's my vomit!
TOO LATE.
YOU ALREADY ATE BUGS!
When you put it that way, it does sound gross.
Icky, but delicious!

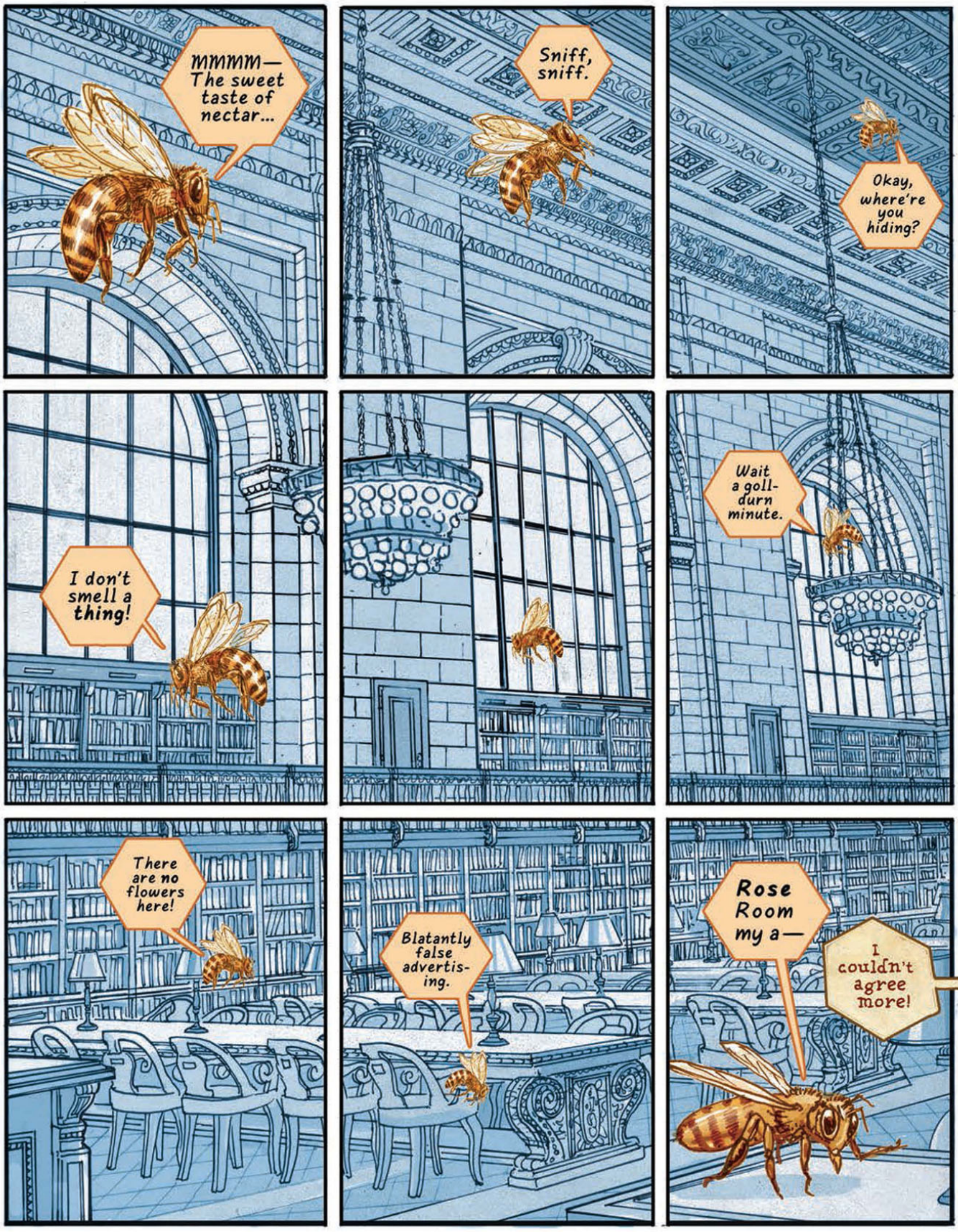

BEE KIND
A one and a two...
Bee Keeping 1300's
"To make a prairie it takes a clover and one bee,
One clover, and a bee,
And revery.
The revery alone will do
If bees are few."
—Emily Dickinson (1830–1886)
Honey bees alone pollinate 80 percent of all flowering

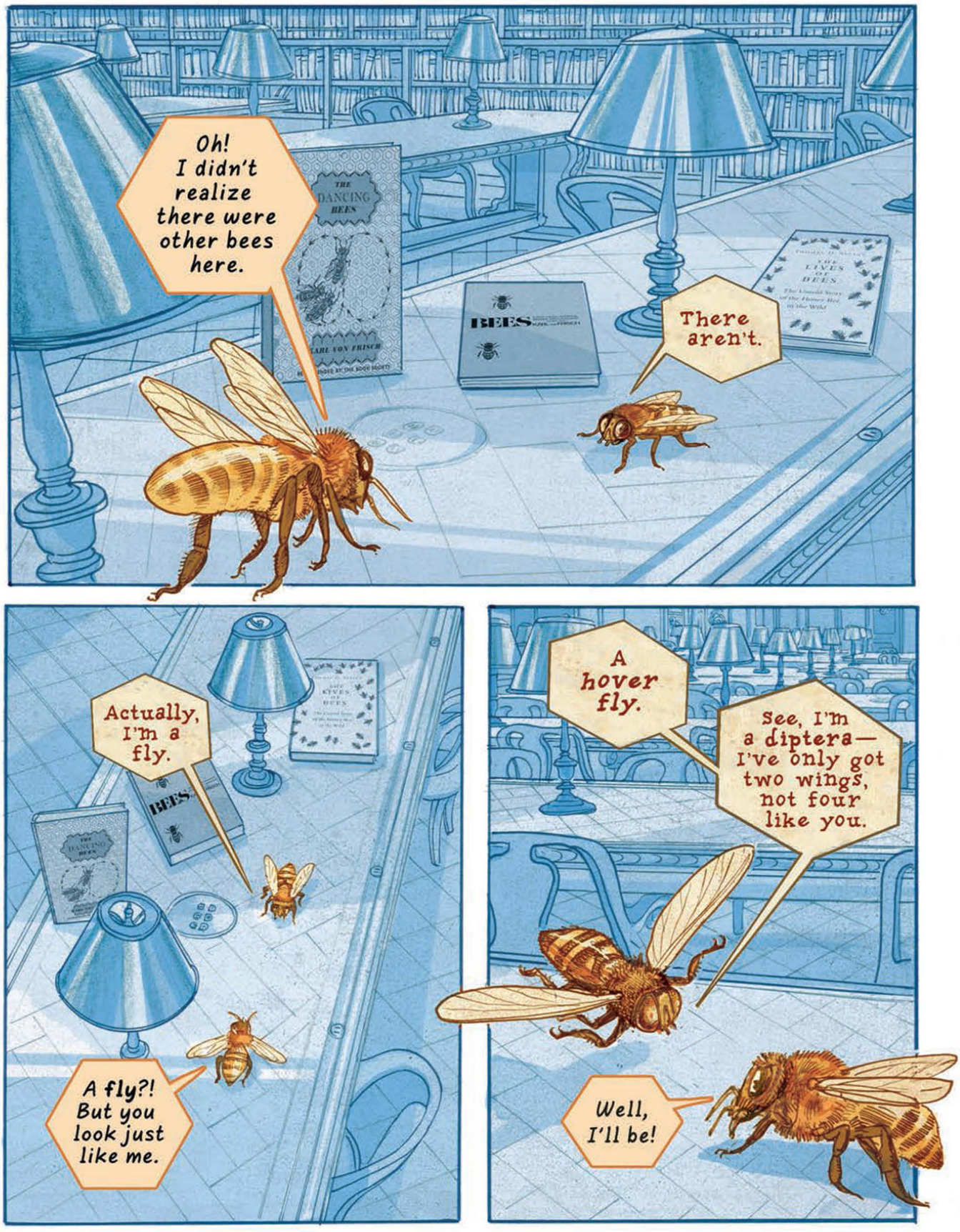
And a three and a four...
Beekeepers 1568 Pieter Bruegel the Elder
Bee Keeping 1500's
TIME (MYA)
plants, including more than 130 types of fruits and vegetables.

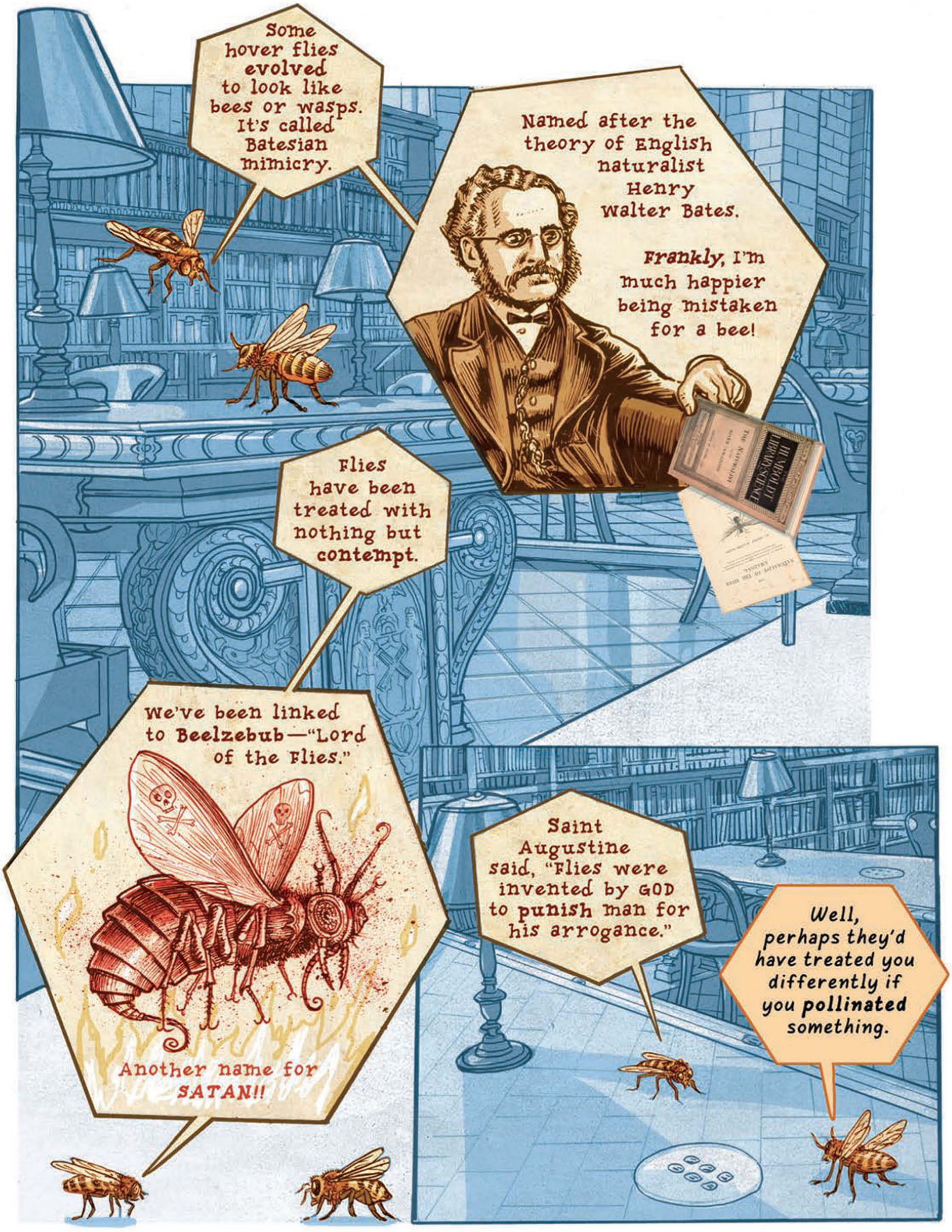

It's remarkable— humans have revered bees for thousands of years.
I mean, just look at all this art and—
Hey! Aren't you going to check this out?
Spain 8000 B.C.E.
Minoan 1700 B.C.E.
Greek 550 B.C.E
Rhodes 600.B.C.
Rome 1623 A.D.
I'm heading upstairs to look for some pollen.
History's not really my thing.
Minoan 1700 B.C.E.
Greek 550 B.C.E
Rhodes 600.B.C.E.
Rome 1623 A.D.

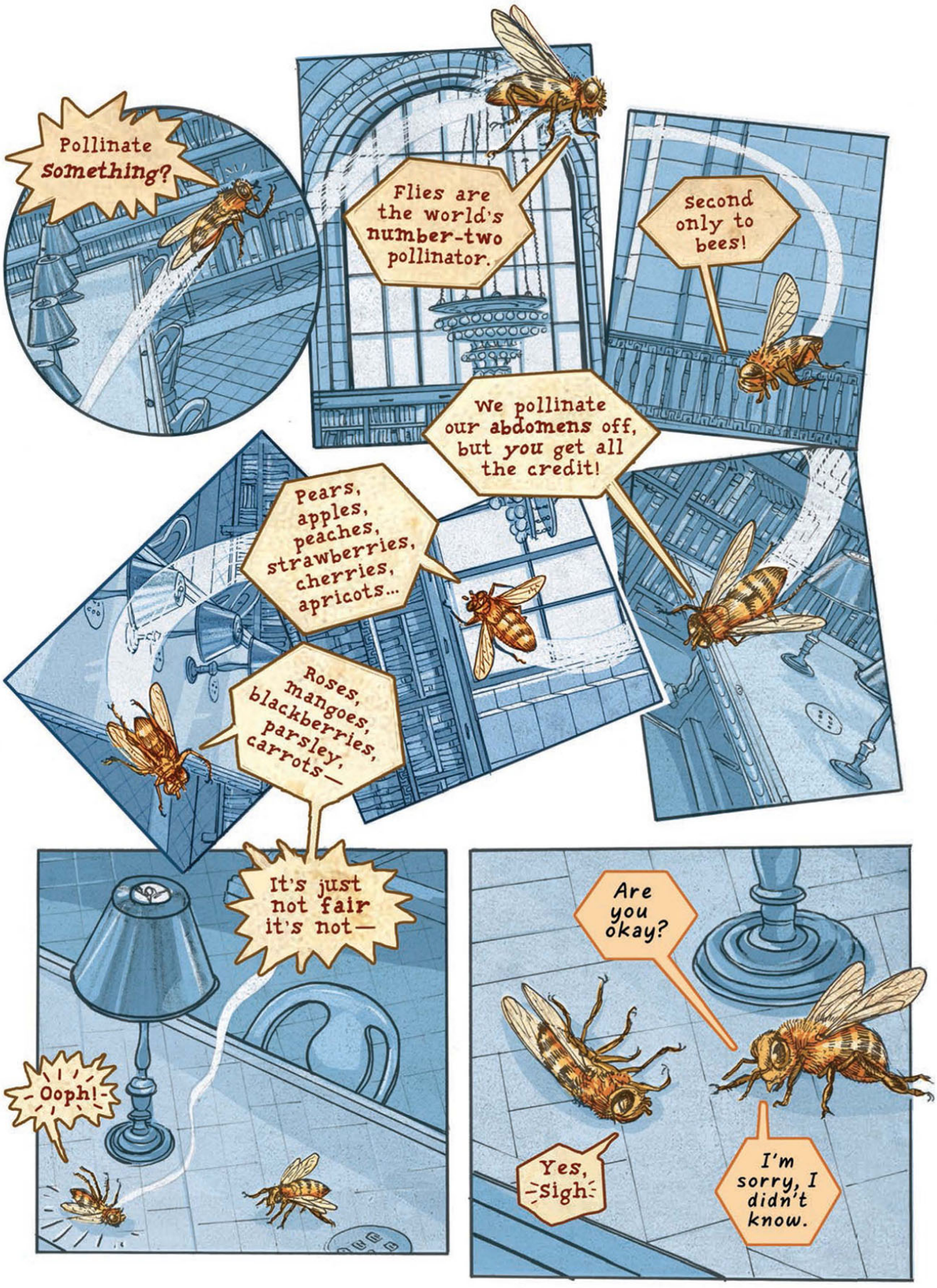
Edward Rachin's classic bear-shaped dispenser design was patented in the U.S. in 1950. Ralph Gamber, president of the Dutch Gold Honey company, began manufacturing "Honeybear" in 1957.

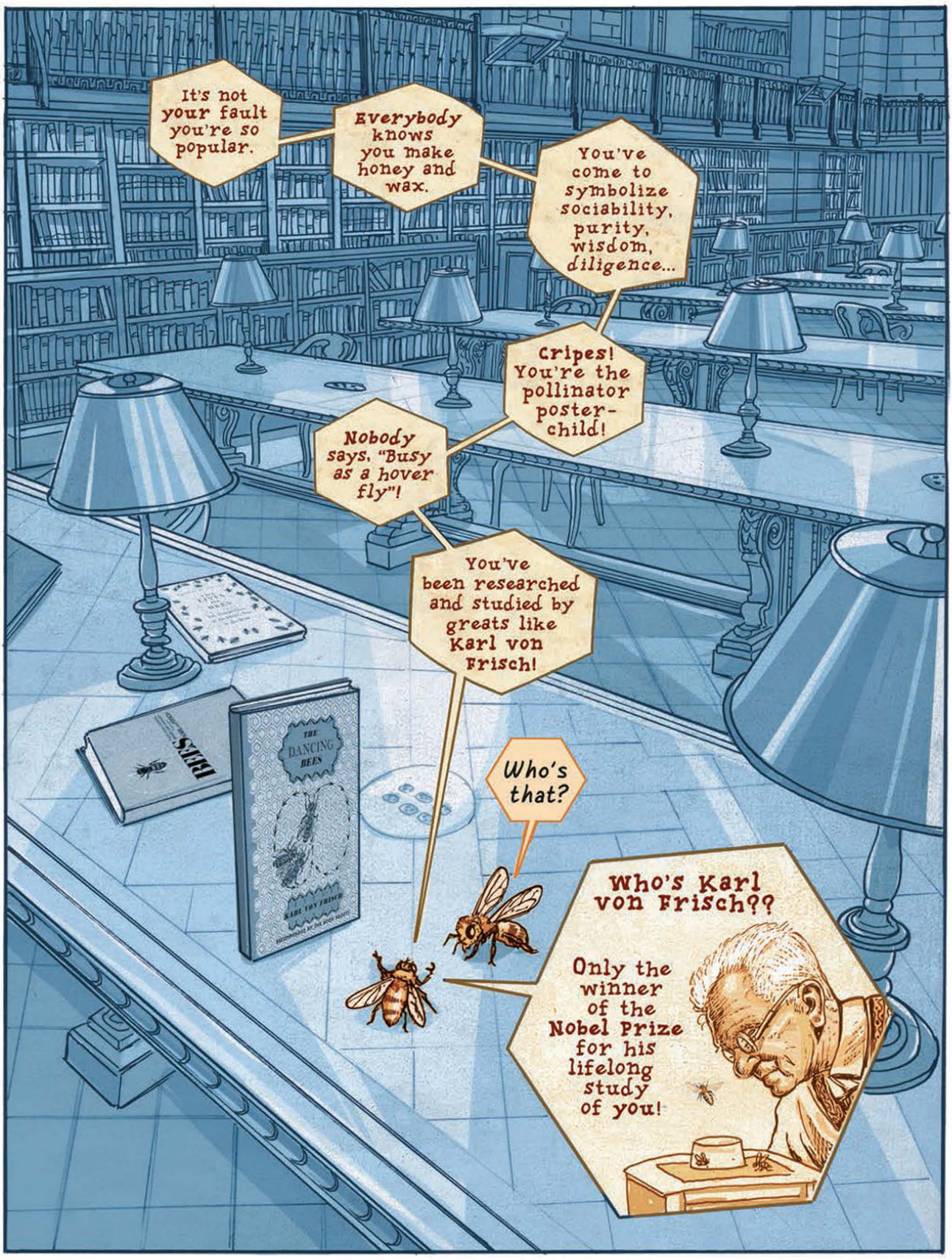
Rose
Reading
Room
Roses?
OH
BOY!


mmmm— The sweet taste of nectar...
Sniff, sniff.
Okay, where're you hiding?
I don't smell a thing!
Wait a goll-durn minute.
There are no flowers here!
Blatantly false advertis-ing.
Rose Room my a—
I couldn't agree more!

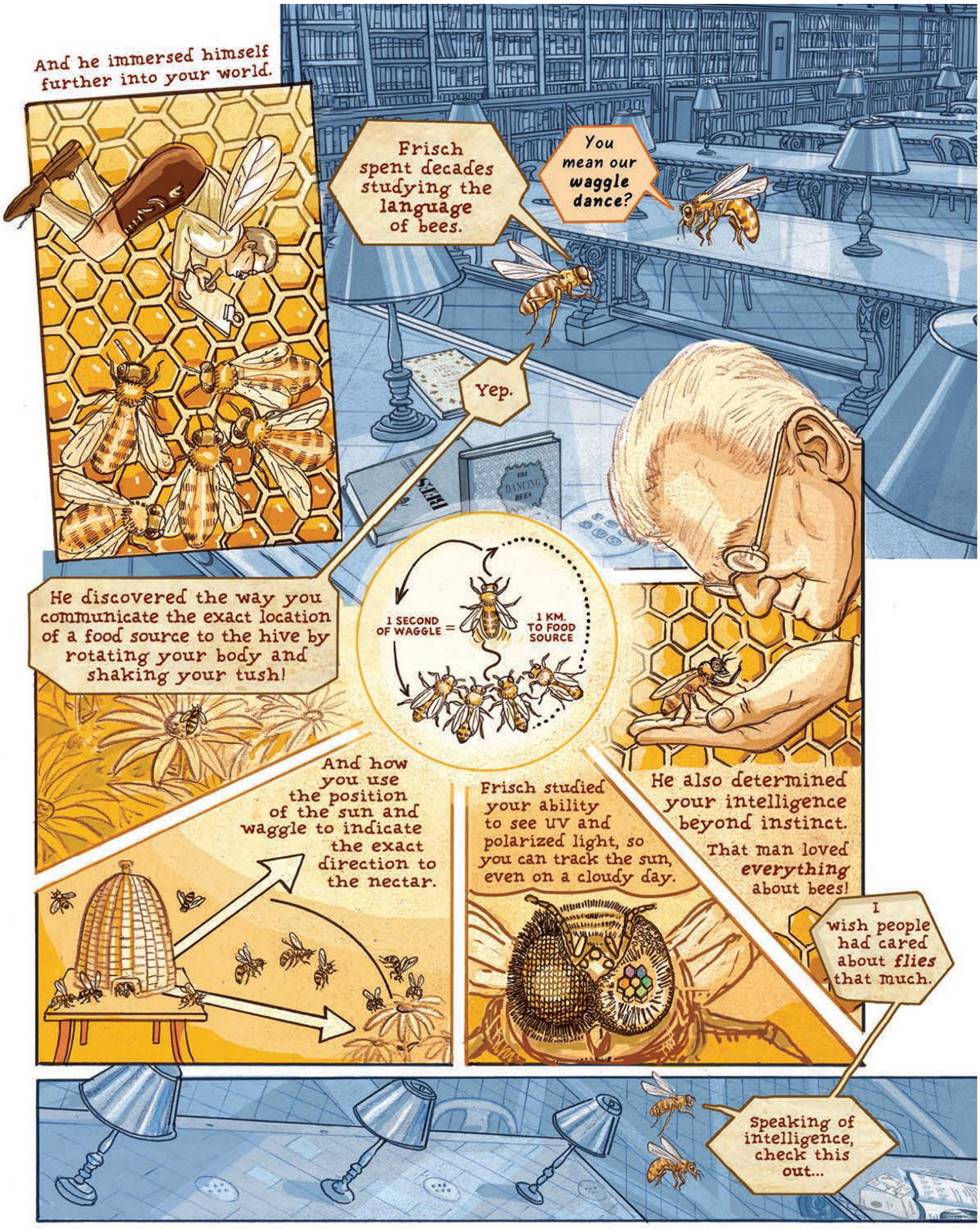

Oh! I didn't realize there were other bees here.
THE DANCING BEES
KARL VON FRISCH
BEES
THE LIVES OF BEES
There aren't.
Actually, I'm a fly.
BEES
THE DANCING BEES
THE LIVES OF BEES
A fly?! But you look just like me.
A hover fly.
See, I'm a diptera— I've only got two wings, not four like you.
Well, I'll be!

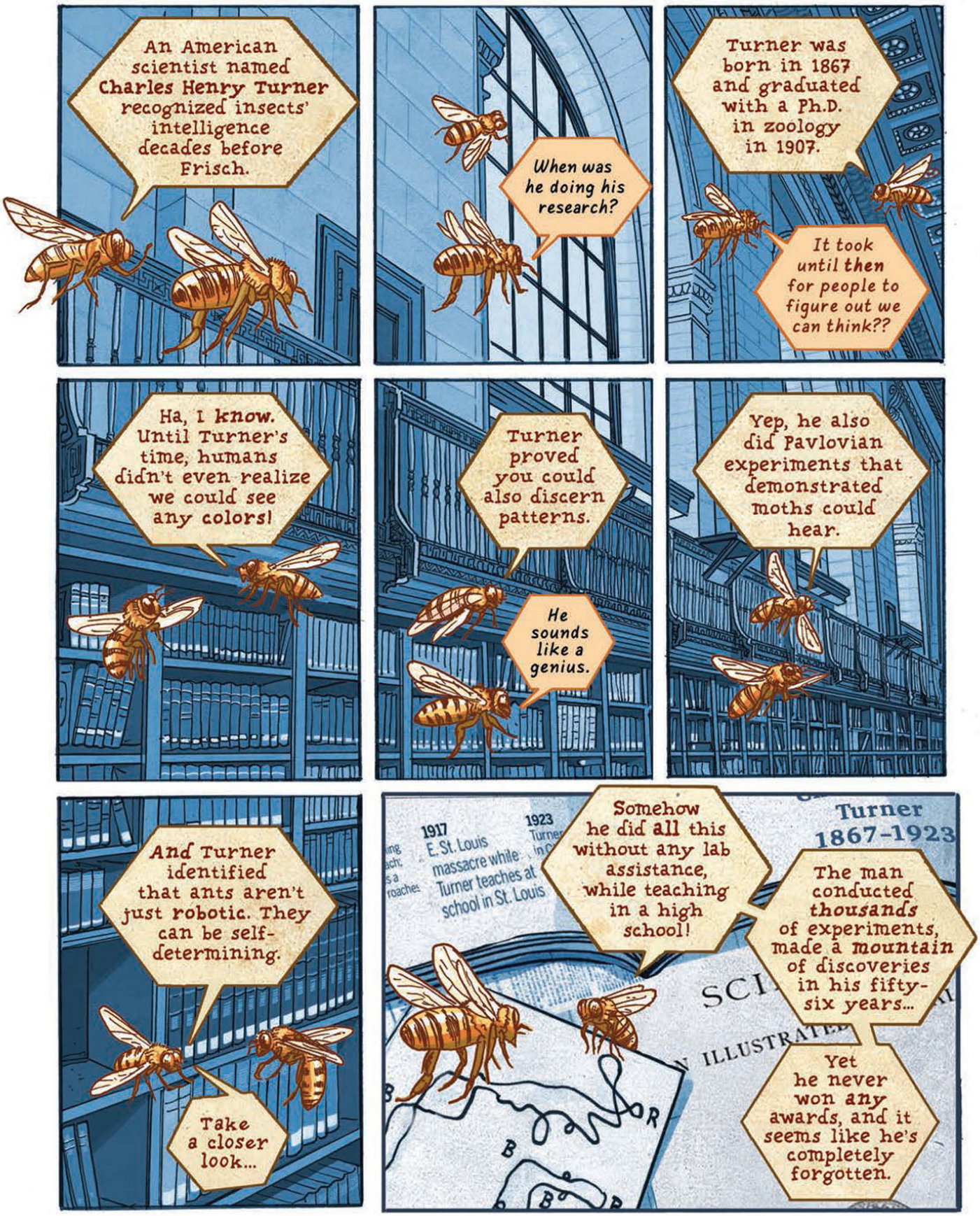

Some hover flies evolved to look like bees or wasps. It's called Batesian mimicry.
Named after the theory of English naturalist Henry Walter Bates.
Frankly, I'm much happier being mistaken for a bee!
THE VARIATION OF ANIMALS AND PLANTS UNDER DOMESTICATION
Flies have been treated with nothing but contempt.
We've been linked to Beelzebub—"Lord of the Flies."
Another name for SATAN!!
Saint Augustine said, "Flies were invented by GOD to punish man for his arrogance."
Well, perhaps they'd have treated you differently if you pollinated something.


Pollinate something?
Flies are the world's number-two pollinator.
Second only to bees!
We pollinate our abdomens off, but you get all the credit!
Pears, apples, peaches, strawberries, cherries, apricots...
Roses, mangoes, blackberries, parsley, carrots—
It's just not fair it's not—
Ooph!
Are you okay?
Yes, -Sigh-
I'm sorry, I didn't know.

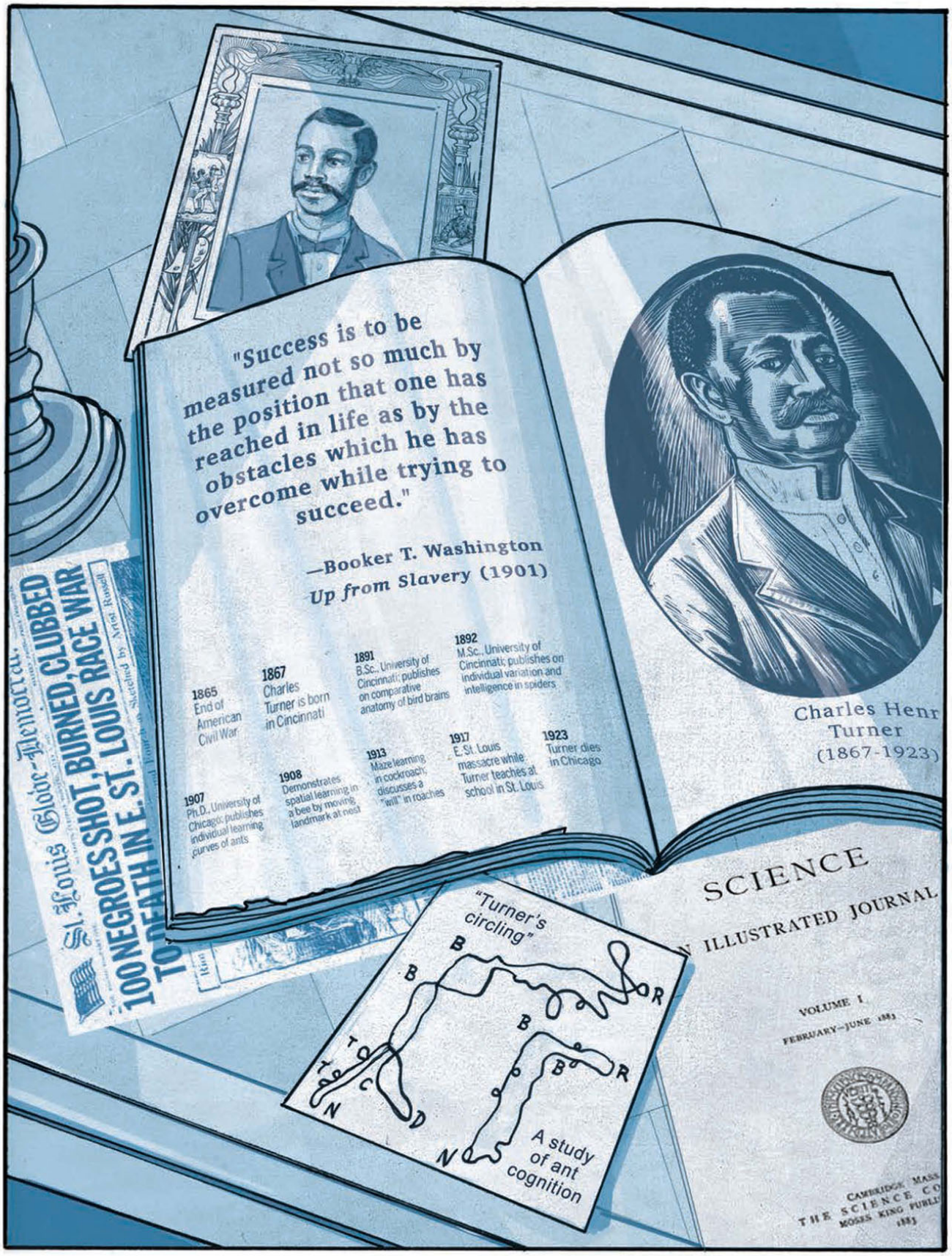

It's not your fault you're so popular.
Everybody knows you make honey and wax.
You've come to symbolize sociability, purity, wisdom, diligence...
Cripes! You're the pollinator poster-child!
Nobody says, "Busy as a hover fly"!
You've been researched and studied by greats like Karl von Frisch!
THE DANCING BEES
KARL VON FRISCH
Who's that?
Who's Karl von Frisch??
Only the winner of the Nobel Prize for his lifelong study of you!

Frisch was a zoology professor in Germany. He conducted breakthrough studies of bees.
After 1933, when Hitler came to power, the Nazis required all civil servants to prove their Aryan ancestry.
Unable to produce sufficent papers, Frisch was denounced by jealous colleagues and antisemitic students who wanted him fired.
HEINRICH HIMMLER, REICH LEADER OF THE NAZI'S DREADED "SS" POLICE.
"Antisemitism is exactly the same as delousing. Getting rid of lice is not a question of ideology, it is a matter of cleanliness."
GIFTGAS!
ZYKLON
Himmler, one of the main architects of the Holocaust, found a new use for the insecticide "Zyklon B"—genocide. Originally created to exterminate bugs, the Nazis turned this poison on humans in gas chambers!
You're making that up!
No.
Amazingly, Frisch was allowed to continue his work!
There was an outbreak of Nosema—a disease killing bees—and the Nazis needed his expertise to save their crop pollinators!
Thanks to bees, Frisch survived the war.


And he immersed himself further into your world.
Frisch spent decades studying the language of bees.
You mean our waggle dance?
Yep.
He discovered the way you communicate the exact location of a food source to the hive by rotating your body and shaking your tush!
1 SECOND OF WAGGLE =
1 KM. TO FOOD SOURCE
And how you use the position of the sun and waggle to indicate the exact direction to the nectar.
Frisch studied your ability to see UV and polarized light, so you can track the sun, even on a cloudy day.
He also determined your intelligence beyond instinct.
That man loved *everything* about bees!
I wish people had cared about *flies* that much.
Speaking of intelligence, check this out...


An American scientist named Charles Henry Turner recognized insects' intelligence decades before Frisch.
When was he doing his research?
Turner was born in 1867 and graduated with a Ph.D. in zoology in 1907.
It took until then for people to figure out we can think??
Ha, I know. Until Turner's time, humans didn't even realize we could see any colors!
Turner proved you could also discern patterns.
He sounds like a genius.
Yep, he also did Pavlovian experiments that demonstrated moths could hear.
And Turner identified that ants aren't just robotic. They can be self-determining.
Take a closer look...
1917 E. St. Louis massacre while Turner teaches at school in St. Louis
1923
Somehow he did all this without any lab assistance, while teaching in a high school!
Turner 1867–1923
The man conducted thousands of experiments, made a mountain of discoveries in his fifty-six years...
Yet he never won any awards, and it seems like he's completely forgotten.

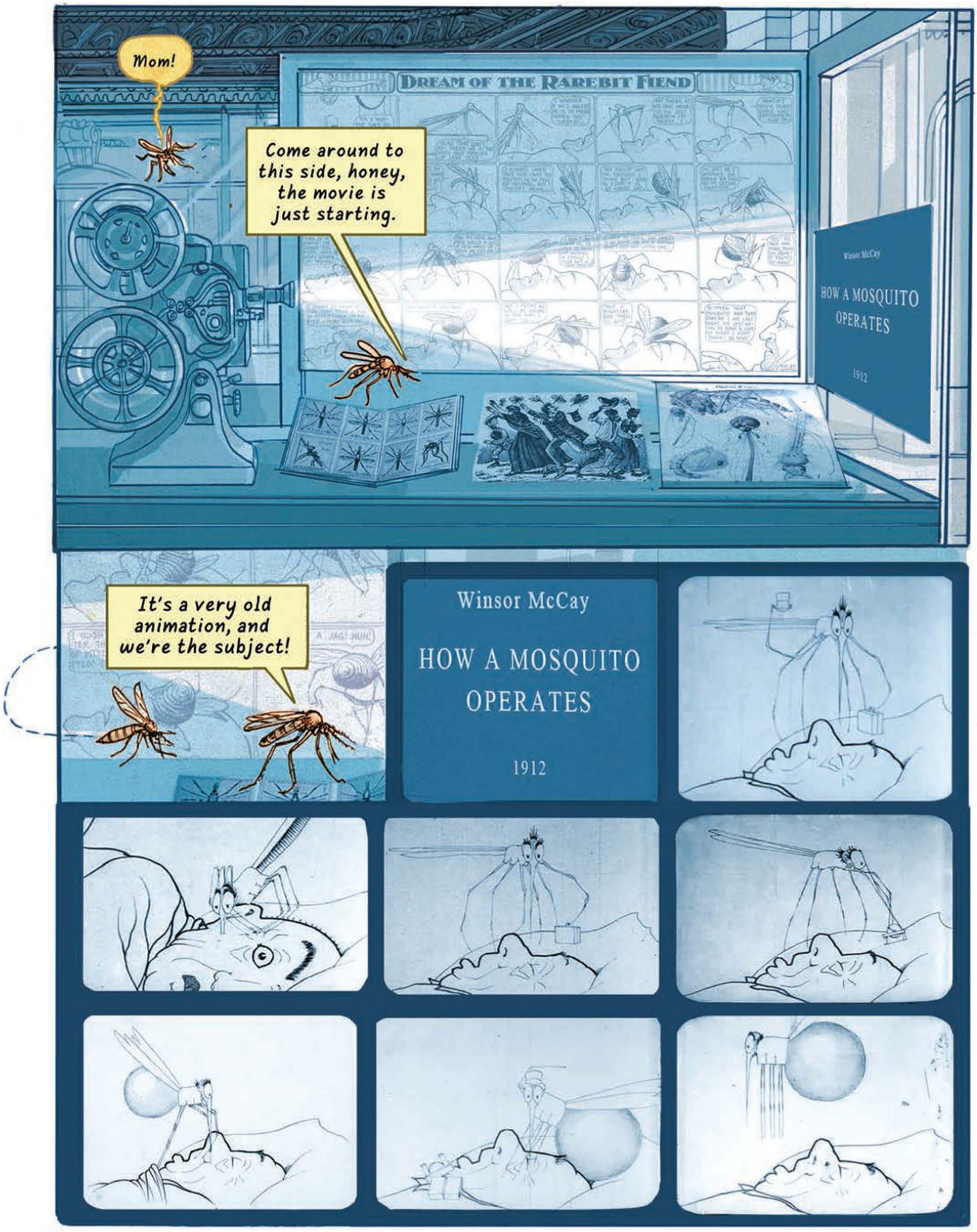
EXIT
Turner isn't even mentioned in the exhibition!
Doesn't make any sense.

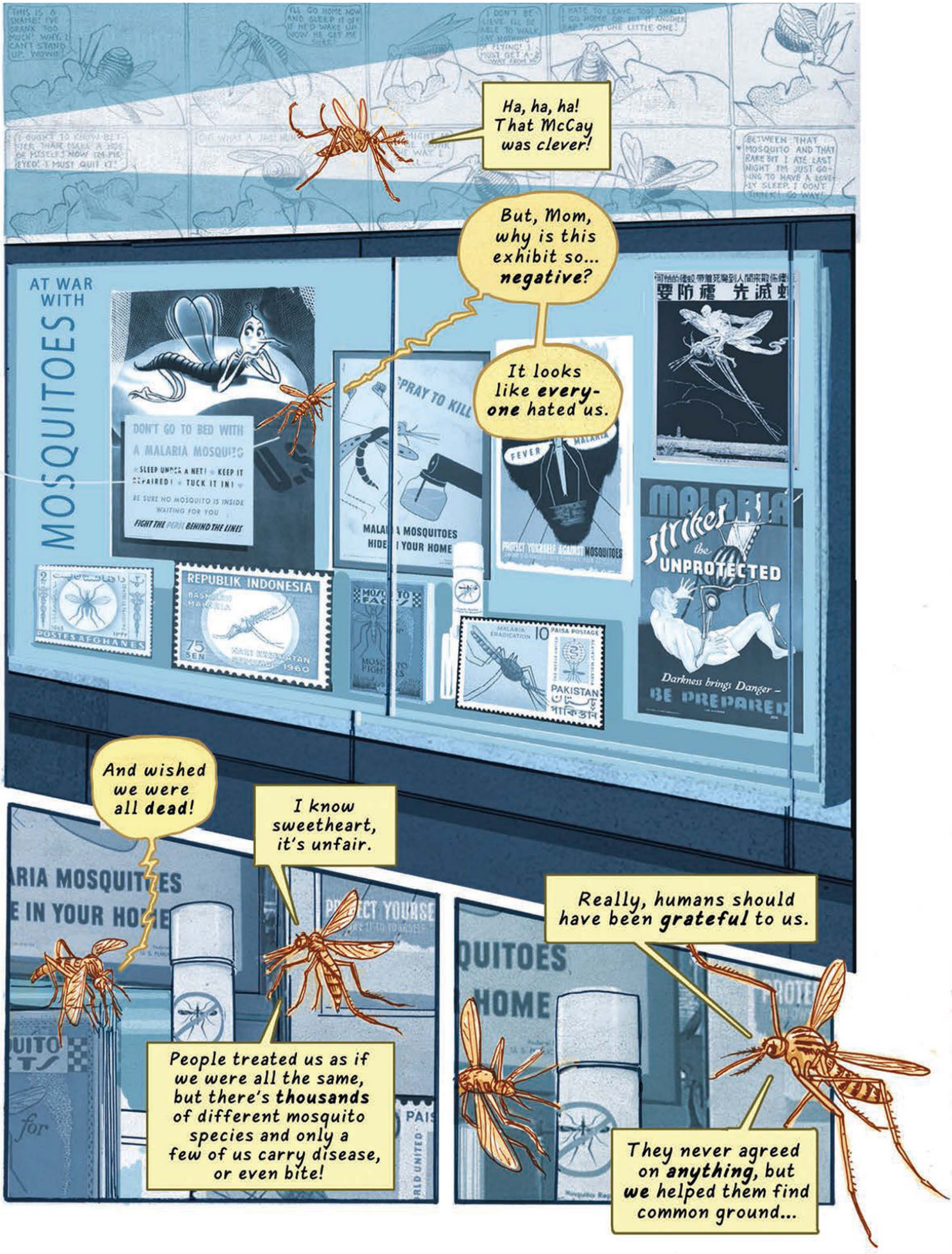

"Success is to be measured not so much by the position that one has reached in life as by the obstacles which he has overcome while trying to succeed."
—Booker T. Washington
Up from Slavery (1901)
1865 End of American Civil War
1867 Charles Turner is born in Cincinnati
1891 B.Sc., University of Cincinnati; publishes on comparative anatomy of bird brains
1892 M.Sc., University of Cincinnati; publishes on individual variation and intelligence in spiders
1907 Ph.D., University of Chicago; publishes individual learning curves of ants
1908 Demonstrates spatial learning in a bee by moving landmark at nest
1913 Maze learning in cockroach; discusses a "will" in roaches
1917 E.St. Louis massacre while Turner teaches at school in St. Louis
1923 Turner dies in Chicago
St. Louis Globe-Democrat
100 NEGROES SHOT, BURNED, CLUBBED TO DEATH IN E. ST. LOUIS RACE WAR
Charles Henry Turner (1867-1923)
SCIENCE
ILLUSTRATED JOURNAL
VOLUME I
FEBRUARY–JUNE 1883
"Turner's circling"
A study of ant cognition

Winsor McCay
(1869–1934)
American cartoonist,
illustrator, and animator
Little Nemo In Slumberland
Published in the
American Examiner, 1912

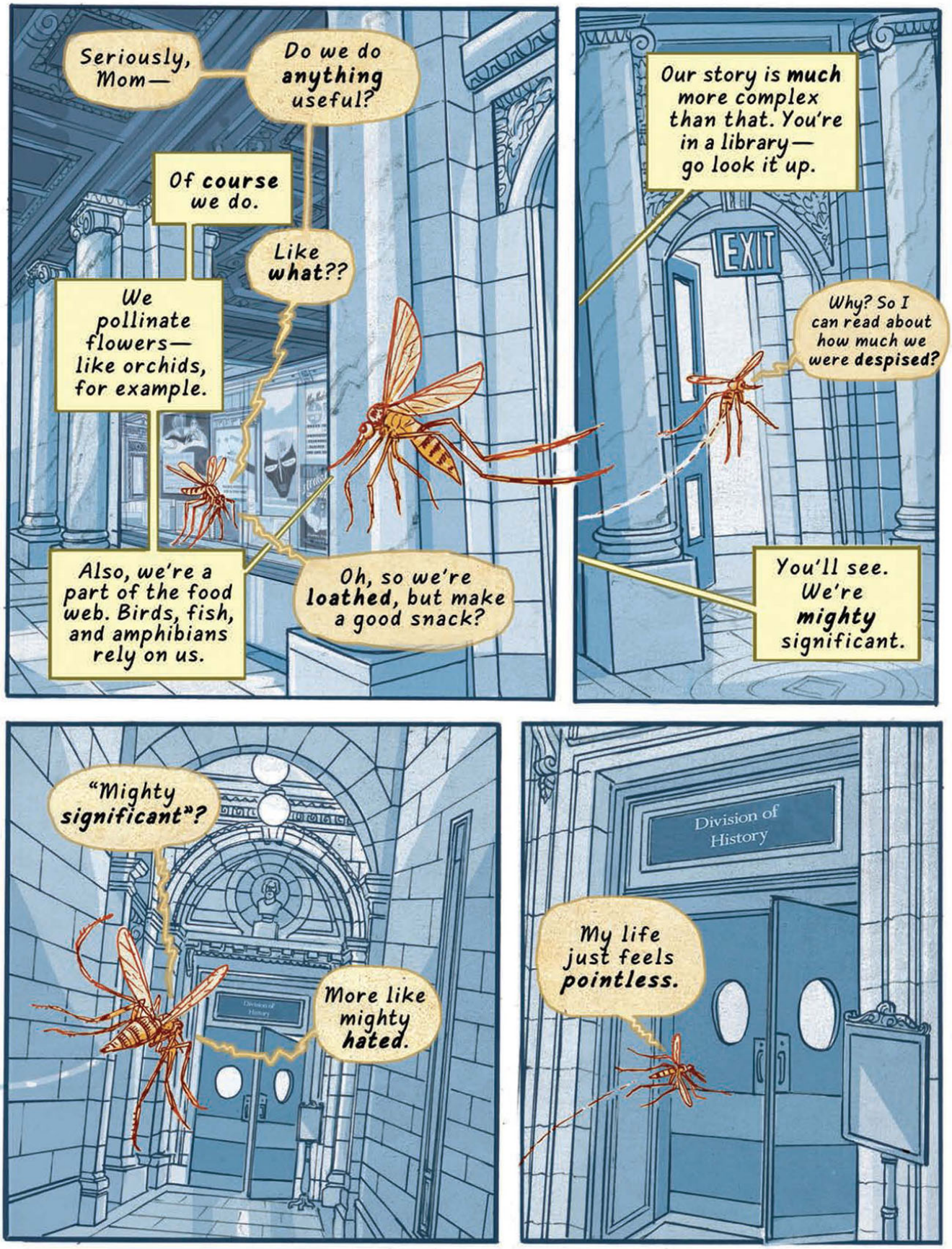
Mommy?
an Inordinate Fondness for Beetles"
AT WAR WITH
MOSQUITOES

Over here, sweetheart.
Extinct & Endanger
REPUBLIK INDONESIA
PAKISTAN
UNPROTECTED
Darkness brings Danger -
BE PREPARED

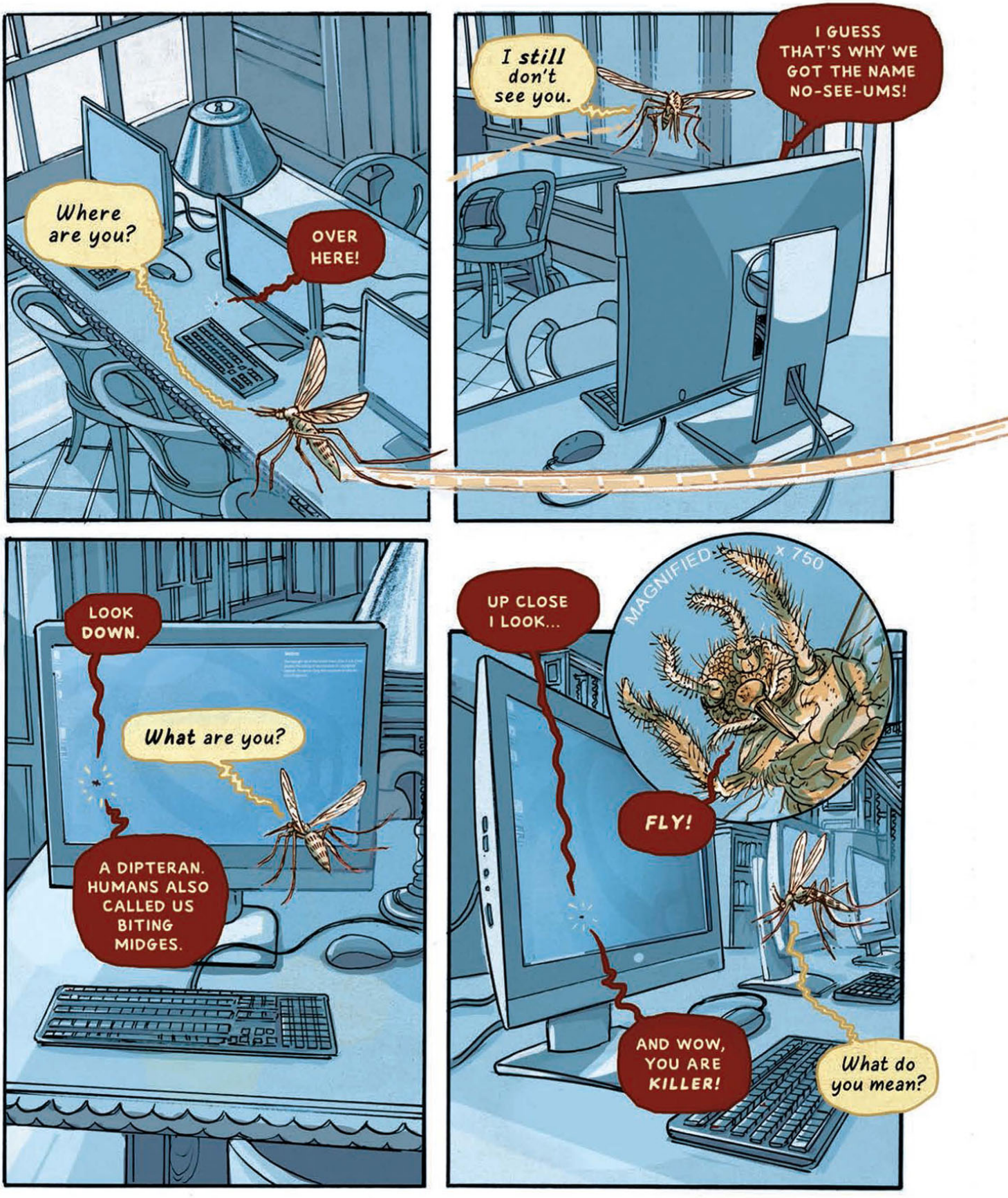

Mom!
Come around to this side, honey, the movie is just starting.
DREAM OF THE RAREBIT FIEND
Winsor McCay
HOW A MOSQUITO OPERATES
1912
It's a very old animation, and we're the subject!
Winsor McCay
HOW A MOSQUITO OPERATES
1912

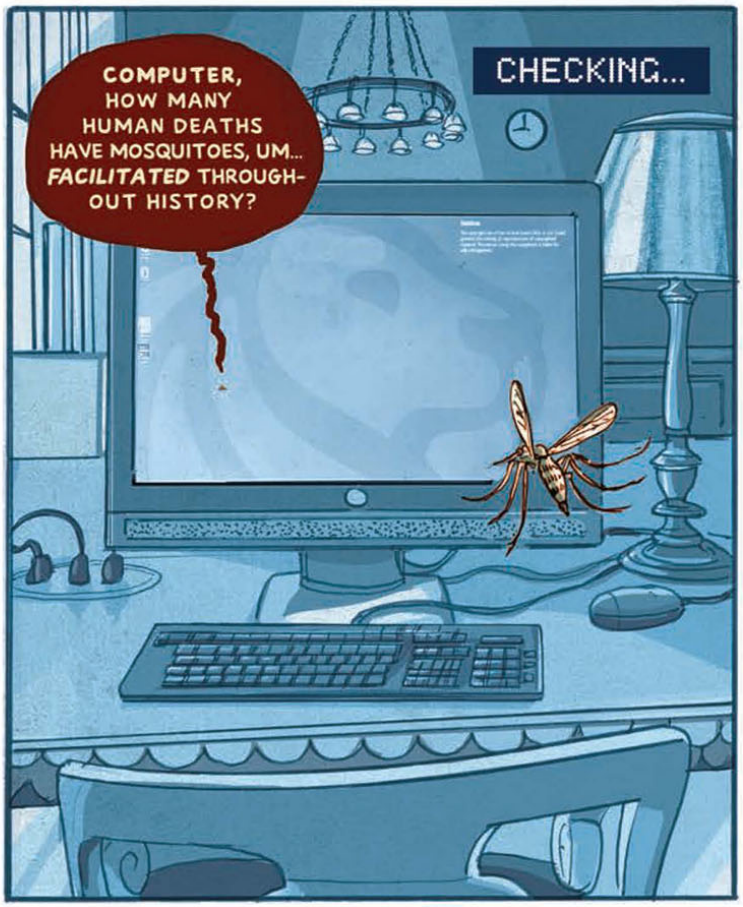

Ha, ha, ha! That McCay was clever!
But, Mom, why is this exhibit so... negative?
It looks like everyone hated us.
AT WAR WITH MOSQUITOES
DON'T GO TO BED WITH A MALARIA MOSQUITO
FIGHT THE PERIL BEHIND THE LINES
REPUBLIK INDONESIA
PAKISTAN
MALARIA strikes the UNPROTECTED
Darkness brings Danger – BE PREPARED
And wished we were all dead!
I know sweetheart, it's unfair.
People treated us as if we were all the same, but there's thousands of different mosquito species and only a few of us carry disease, or even bite!
Really, humans should have been grateful to us.
They never agreed on anything, but we helped them find common ground...

平手打ち
SLAP!
ляпас
schlagen
slag
थप्पड
يصفع
σφαλιάρα
BOFETADA

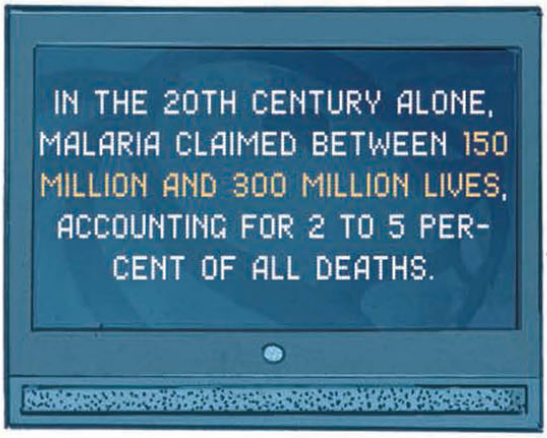

Seriously, Mom—
Do we do anything useful?
Of course we do.
We pollinate flowers—like orchids, for example.
Like what??
Also, we're a part of the food web. Birds, fish, and amphibians rely on us.
Oh, so we're loathed, but make a good snack?
Our story is much more complex than that. You're in a library—go look it up.
EXIT
Why? So I can read about how much we were despised?
You'll see. We're mighty significant.
"Mighty significant"?
More like mighty hated.
Division of History
My life just feels pointless.

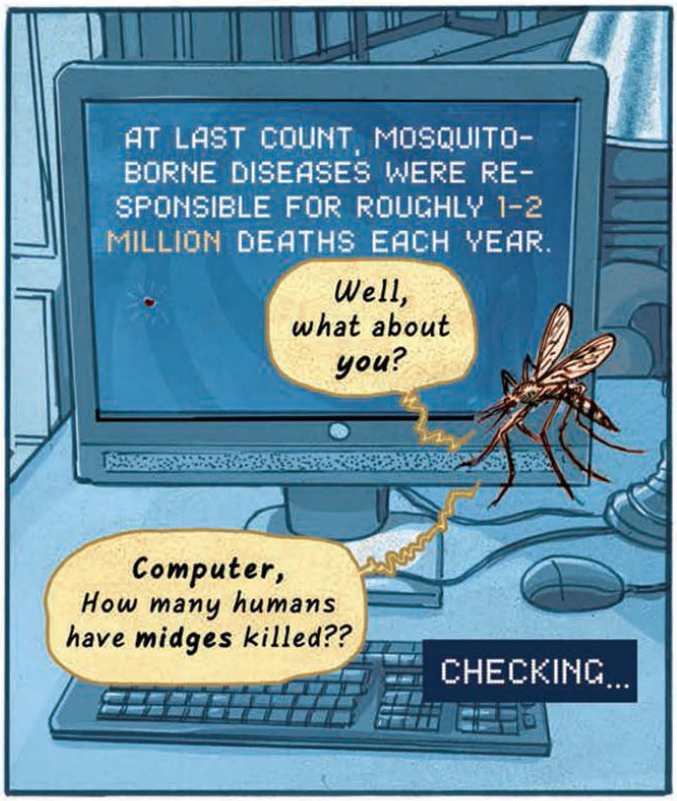
If mosquitoes disappeared, nobody would even care!
HEY— GIRLFRIEND! COME HERE.
W-who said that?

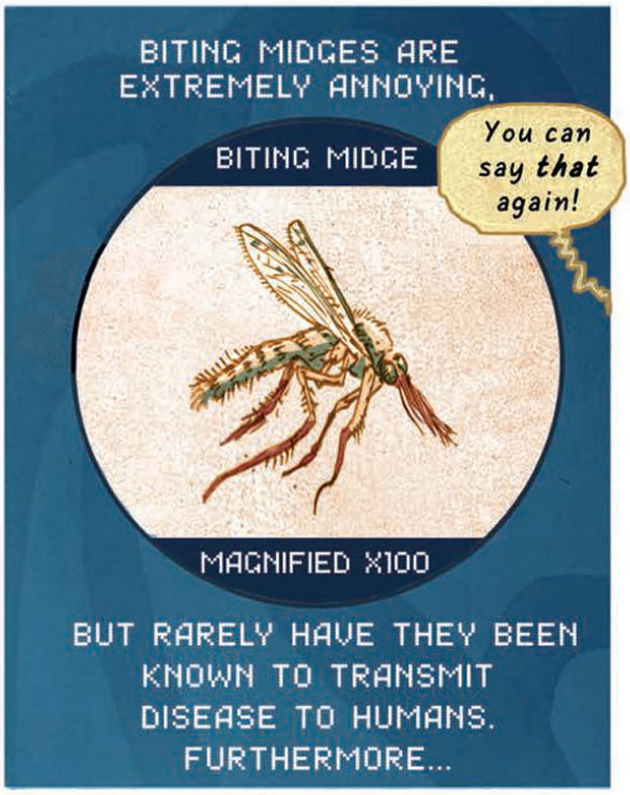

Where are you?
OVER HERE!
I still don't see you.
I GUESS THAT'S WHY WE GOT THE NAME NO-SEE-UMS!
LOOK DOWN.
What are you?
A DIPTERAN. HUMANS ALSO CALLED US BITING MIDGES.
UP CLOSE I LOOK...
MAGNIFIED x 750
FLY!
AND WOW, YOU ARE KILLER!
What do you mean?

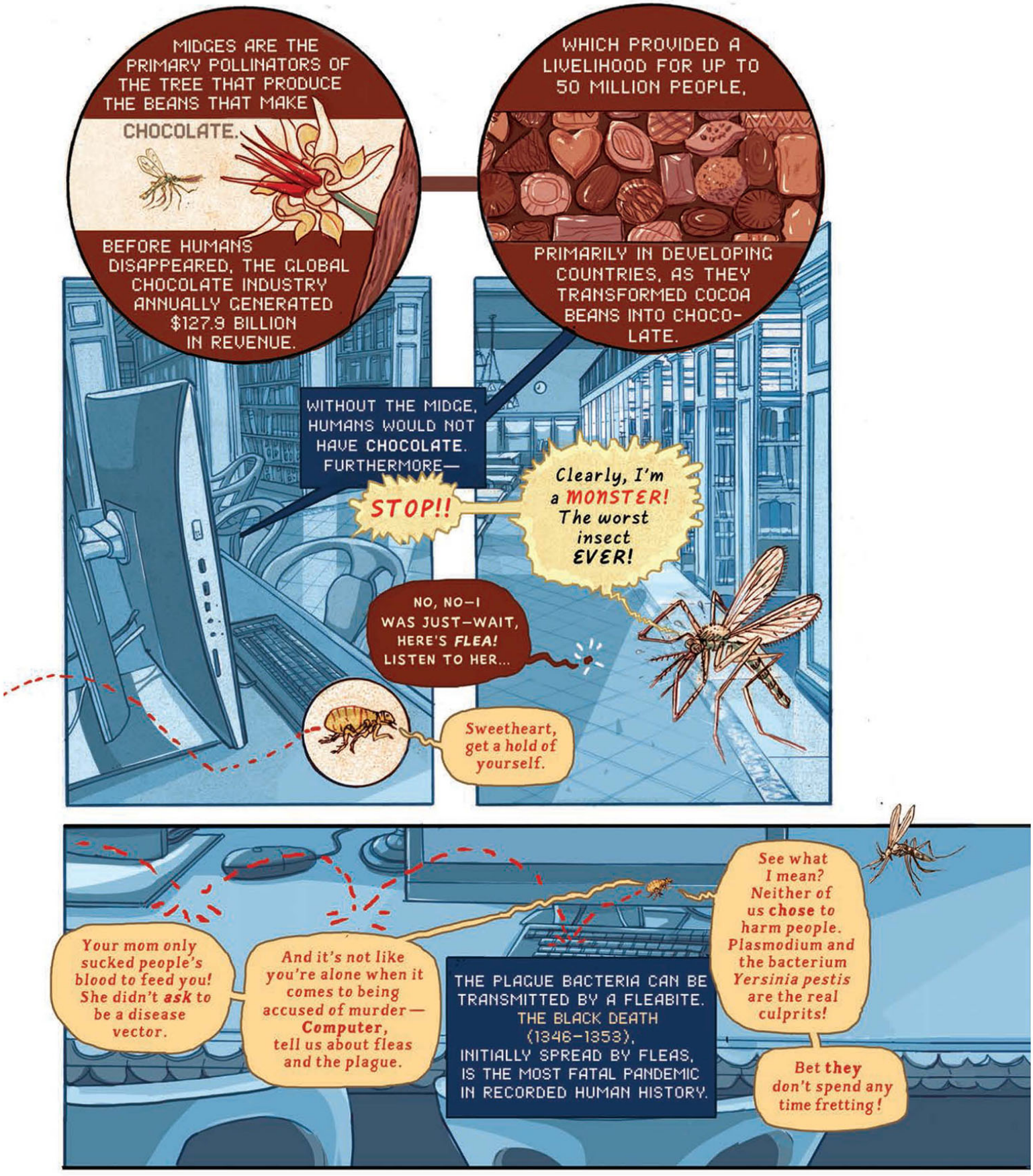

COMPUTER, HOW MANY HUMAN DEATHS HAVE MOSQUITOES, UM... *FACILITATED* THROUGHOUT HISTORY?
CHECKING...

OVER THE COURSE OF 200,000 YEARS, 108 BILLION PEOPLE HAVE LIVED ON EARTH. AND NEARLY HALF, 52 BILLION, HAVE BEEN KILLED BY MOSQUITO-BORNE DISEASES.


IN THE 20TH CENTURY ALONE, MALARIA CLAIMED BETWEEN 150 MILLION AND 300 MILLION LIVES, ACCOUNTING FOR 2 TO 5 PERCENT OF ALL DEATHS.


AT LAST COUNT, MOSQUITO-BORNE DISEASES WERE RESPONSIBLE FOR ROUGHLY 1-2 MILLION DEATHS EACH YEAR.
*Well, what about **you**?*
*Computer, How many humans have **midges** killed??*
CHECKING...


BITING MIDGES ARE EXTREMELY ANNOYING,
BITING MIDGE
*You can say **that** again!*
MAGNIFIED X100
BUT RARELY HAVE THEY BEEN KNOWN TO TRANSMIT DISEASE TO HUMANS. FURTHERMORE...


MIDGES ARE THE PRIMARY POLLINATORS OF THE TREE THAT PRODUCE THE BEANS THAT MAKE CHOCOLATE.
BEFORE HUMANS DISAPPEARED, THE GLOBAL CHOCOLATE INDUSTRY ANNUALLY GENERATED $127.9 BILLION IN REVENUE.
WHICH PROVIDED A LIVELIHOOD FOR UP TO 50 MILLION PEOPLE,
PRIMARILY IN DEVELOPING COUNTRIES, AS THEY TRANSFORMED COCOA BEANS INTO CHOCOLATE.
WITHOUT THE MIDGE, HUMANS WOULD NOT HAVE CHOCOLATE. FURTHERMORE—
STOP!!
Clearly, I'm a MONSTER! The worst insect EVER!
NO, NO—I WAS JUST—WAIT, HERE'S FLEA! LISTEN TO HER...
Sweetheart, get a hold of yourself.
Your mom only sucked people's blood to feed you! She didn't ask to be a disease vector.
And it's not like you're alone when it comes to being accused of murder— Computer, tell us about fleas and the plague.
THE PLAGUE BACTERIA CAN BE TRANSMITTED BY A FLEABITE. THE BLACK DEATH (1346–1353), INITIALLY SPREAD BY FLEAS, IS THE MOST FATAL PANDEMIC IN RECORDED HUMAN HISTORY.
See what I mean? Neither of us chose to harm people. Plasmodium and the bacterium Yersinia pestis are the real culprits!
Bet they don't spend any time fretting!

You really need to look at the big picture...

Midge, would you call it up?

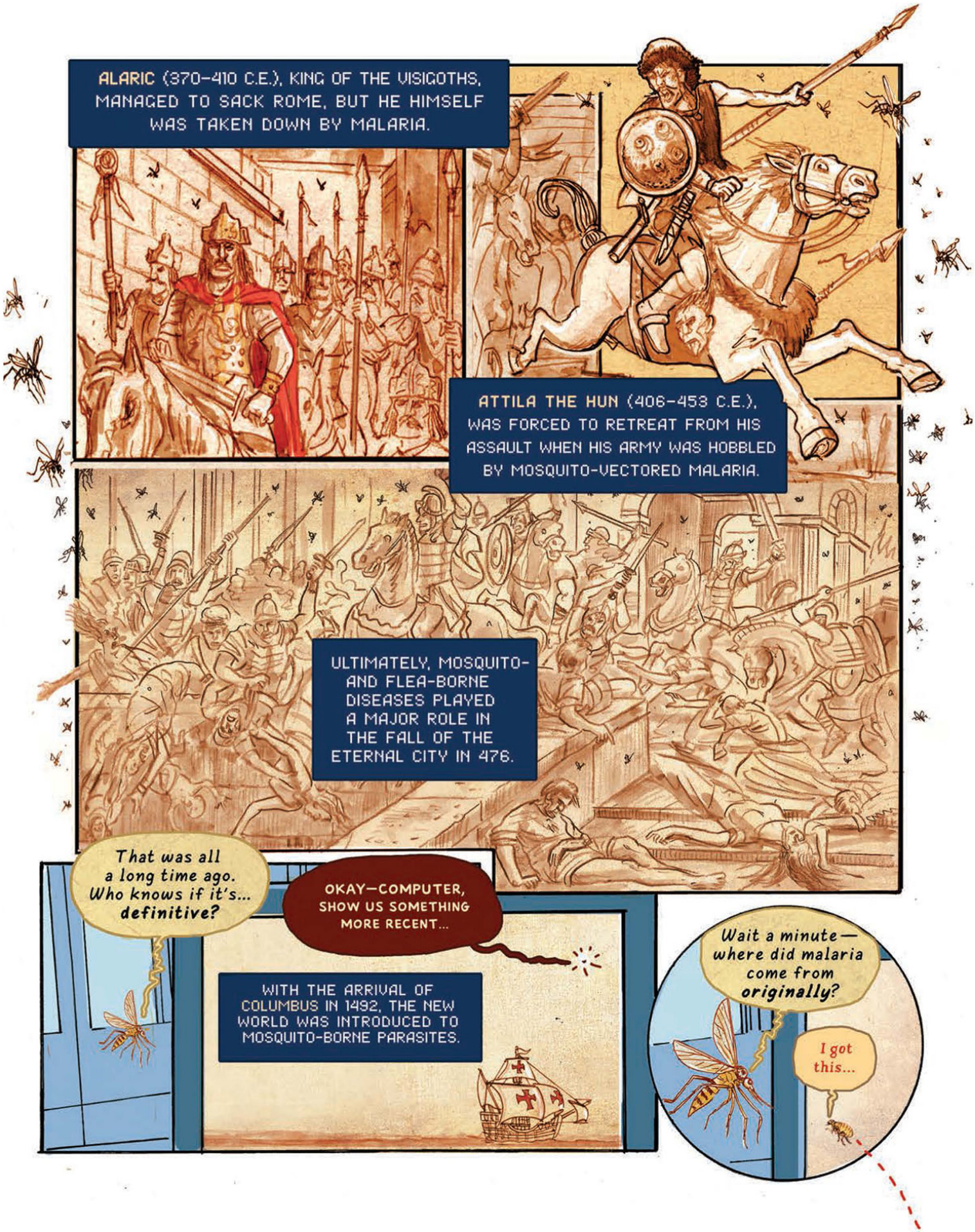
COMPUTER, SHOW US THE ROLE MOSQUITOES HAVE PLAYED IN HISTORY.

CHECKING...

MANY HISTORIANS BELIEVE THAT **ALEXANDER THE GREAT** (356–323 B.C.E.), KING OF MACEDON, WAS STOPPED FROM WORLD DOMINATION WHEN HE DIED FROM MOSQUITO-BORNE MALARIA AT THE AGE OF 32.

HANNIBAL (247–182 B.C.E.), CONSIDERED ONE OF THE GREATEST MILITARY COMMANDERS IN HISTORY, LOST AN EYE TO MALARIA. THE THREAT OF MOSQUITOES IN THE MARSHES SURROUNDING ROME PREVENTED HIS ARMY FROM TAKING DOWN THE EMPIRE.

THE PONTINE MARSHES, A MOSQUITO BREEDING GROUND, WERE A DETERRENT TO ALL INVADING FORCES AND HELPED THE ROMAN EMPIRE SURVIVE A MULTITUDE OF ATTACKERS.


ALARIC (370–410 C.E.), KING OF THE VISIGOTHS, MANAGED TO SACK ROME, BUT HE HIMSELF WAS TAKEN DOWN BY MALARIA.
ATTILA THE HUN (406–453 C.E.), WAS FORCED TO RETREAT FROM HIS ASSAULT WHEN HIS ARMY WAS HOBBLED BY MOSQUITO-VECTORED MALARIA.
ULTIMATELY, MOSQUITO- AND FLEA-BORNE DISEASES PLAYED A MAJOR ROLE IN THE FALL OF THE ETERNAL CITY IN 476.
That was all a long time ago. Who knows if it's... definitive?
OKAY—COMPUTER, SHOW US SOMETHING MORE RECENT...
WITH THE ARRIVAL OF COLUMBUS IN 1492, THE NEW WORLD WAS INTRODUCED TO MOSQUITO-BORNE PARASITES.
Wait a minute— where did malaria come from originally?
I got this...

The name malaria was coined by the ancient Romans, who believed the sickness came from "**mal aria**"—"bad air" in the swamps. But the bacteria has been around since the **dinosaurs**...

SLAP!

Malaria transferred from monkeys to early humans **millions** of years ago and slowly made its way around the globe...

SLAP!

Malaria was described on Mesopotamian clay tablets in 2000 B.C.E.

SLAP!

It was recorded in Chinese scrolls going back to 2700 B.C.E.

SLAP!

Egyptians wrote about it on papyri during King Tut's rule...

And Tut probably died from malaria!

SLAP!

The illness was referenced in Hindu texts dating back to the 6th century B.C.E.

SLAP!

SLAP!

SLAP!

In Greece, about 400 B.C.E., the "father of medicine," Hippocrates, wrote about the symptoms, though he, too, thought they were caused by fumes.

SLAP!

A number of scientists had determined bacteria was the cause of the illness, but it wasn't until 1897 that Ronald Ross, a medical officer stationed in India, identified mosquitoes as the vector.

This won him the Nobel Prize.

SMUSH

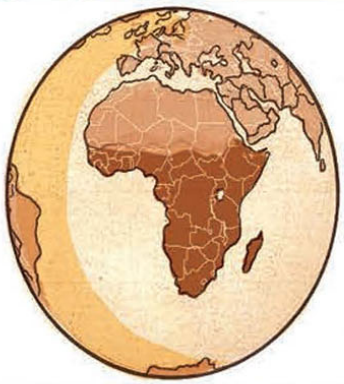
No cure for malaria had been discovered, but for thousands of years the bitter bark from the cinchona tree was used to alleviate symptoms.

The fever tree bark contained quinine, which became a popular medication in Europe.

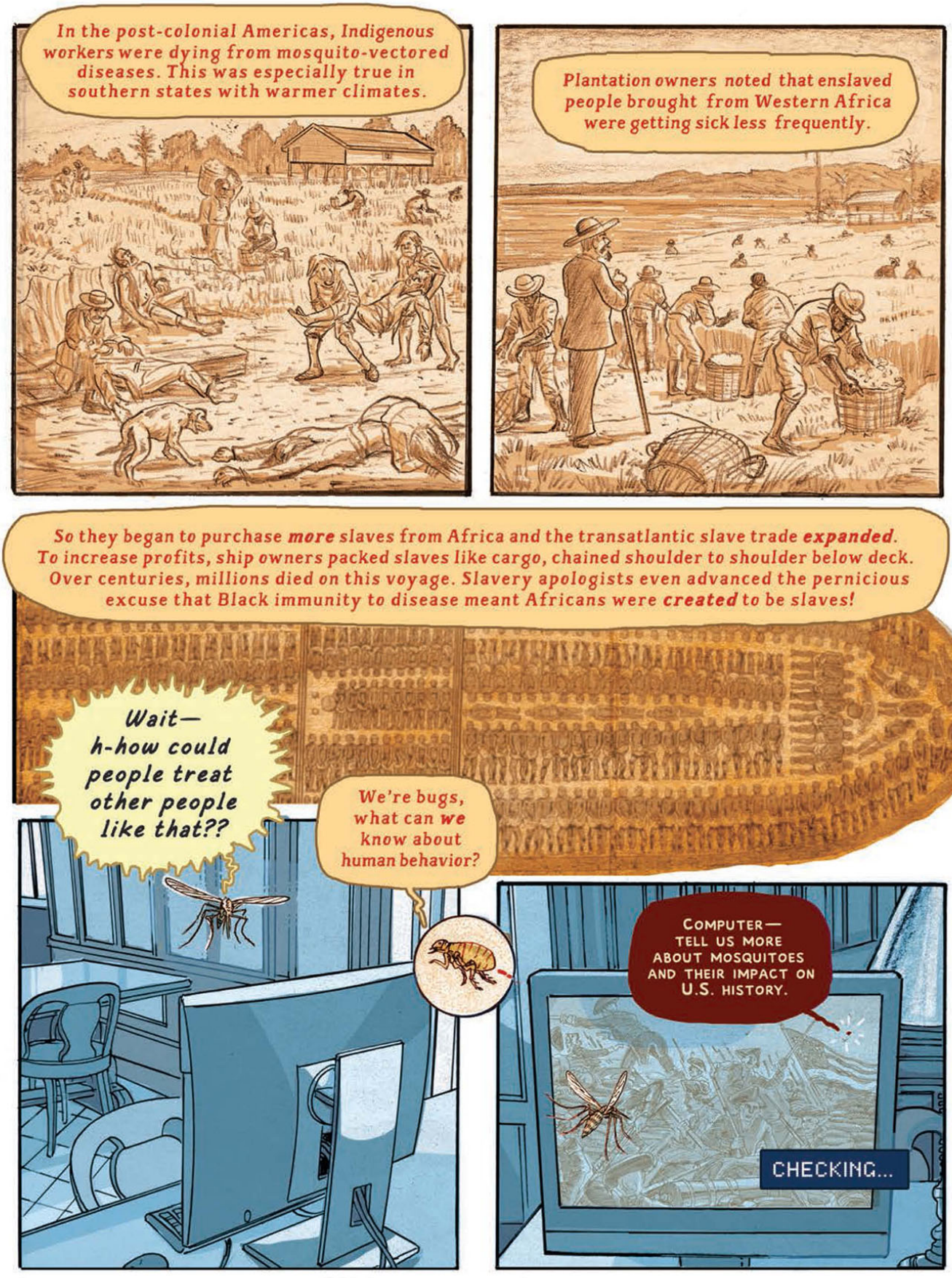
Especially after it was sweetened in a tonic with lime and alcohol.

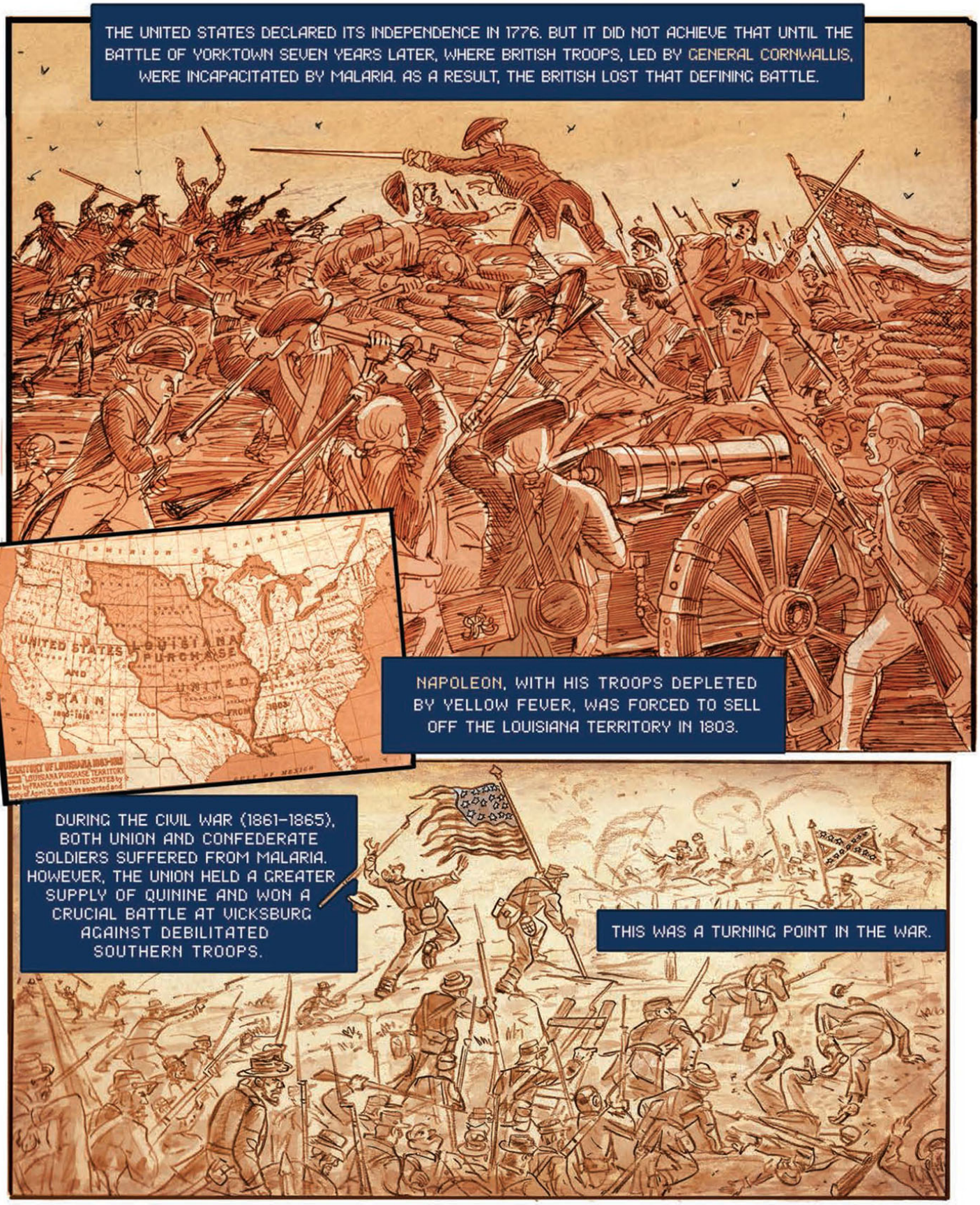
A remedy called gin and tonic.

Because malaria and yellow fever had first appeared in sub-Saharan Africa, the people living in these areas developed some immunity through exposure over millennia.



But that came with a ***terrible*** price...


In the post-colonial Americas, Indigenous workers were dying from mosquito-vectored diseases. This was especially true in southern states with warmer climates.
Plantation owners noted that enslaved people brought from Western Africa were getting sick less frequently.
So they began to purchase **more** slaves from Africa and the transatlantic slave trade **expanded**. To increase profits, ship owners packed slaves like cargo, chained shoulder to shoulder below deck. Over centuries, millions died on this voyage. Slavery apologists even advanced the pernicious excuse that Black immunity to disease meant Africans were **created** to be slaves!
Wait— h-how could people treat other people like that??
We're bugs, what can **we** know about human behavior?
COMPUTER— TELL US MORE ABOUT MOSQUITOES AND THEIR IMPACT ON U.S. HISTORY.
CHECKING...


THE UNITED STATES DECLARED ITS INDEPENDENCE IN 1776. BUT IT DID NOT ACHIEVE THAT UNTIL THE BATTLE OF YORKTOWN SEVEN YEARS LATER, WHERE BRITISH TROOPS, LED BY GENERAL CORNWALLIS, WERE INCAPACITATED BY MALARIA. AS A RESULT, THE BRITISH LOST THAT DEFINING BATTLE.
NAPOLEON, WITH HIS TROOPS DEPLETED BY YELLOW FEVER, WAS FORCED TO SELL OFF THE LOUISIANA TERRITORY IN 1803.
DURING THE CIVIL WAR (1861–1865), BOTH UNION AND CONFEDERATE SOLDIERS SUFFERED FROM MALARIA. HOWEVER, THE UNION HELD A GREATER SUPPLY OF QUININE AND WON A CRUCIAL BATTLE AT VICKSBURG AGAINST DEBILITATED SOUTHERN TROOPS.
THIS WAS A TURNING POINT IN THE WAR.

COMPUTER— LET'S GO BACK TO ITALY'S PONTINE MARSHES.

IN 1928, ITALY'S FASCIST DICTATOR, BENITO MUSSOLINI, ENACTED AN ENORMOUS ENGINEERING PROJECT. HE DRAINED THE MARSHES TO ERADICATE MALARIA, TO RECLAIM THE LAND FOR DEVELOPMENT AND ESPECIALLY TO DEMONSTRATE THE POWER OF THE STATE.

IN 1943, ERICH MARTINI, AN ENTOMOLOGIST IN THE NAZI PARTY, PROPOSED A **DIFFERENT** SCHEME TO HITLER...

AS BRITISH AND AMERICAN TROOPS ADVANCED IN ITALY, THE NAZIS **REFLOODED** THE PONTINE MARSHES,THEN RELEASED MILLIONS OF MOSQUITO LARVAE.

THOUGH THE NAZIS LOST THE WAR, UTILIZING MOSQUITOES AS A BIOLOGICAL WEAPON CAUSED MALARIA TO SPREAD IN ITALY FOR DECADES.

*See you've been treated as the **villain**, but you've been manipulated!*

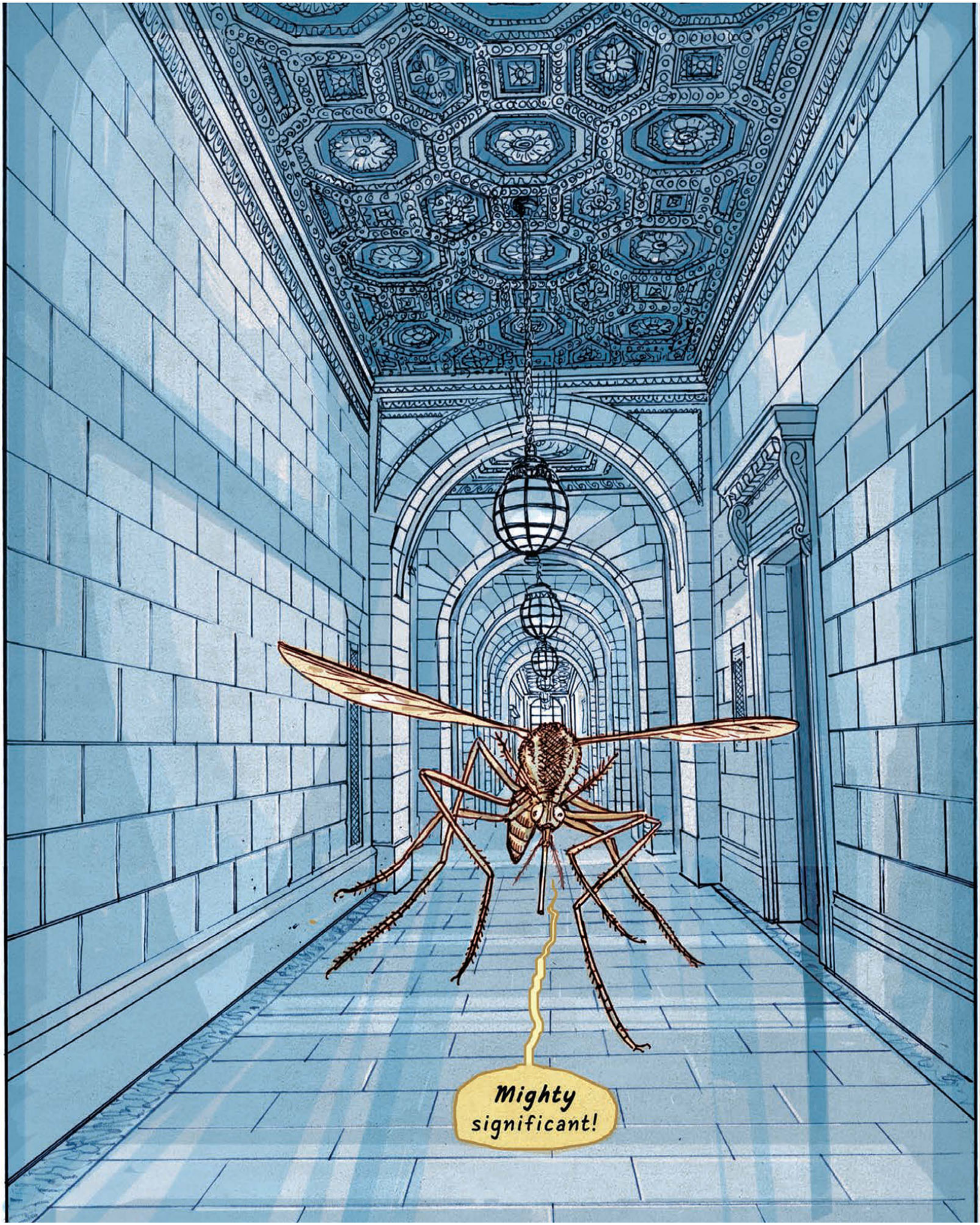
*Exploited by humans and used by bacteria. You've never killed **anybody**.*

*But mosquitoes **have** played a key role in the course of human history!*

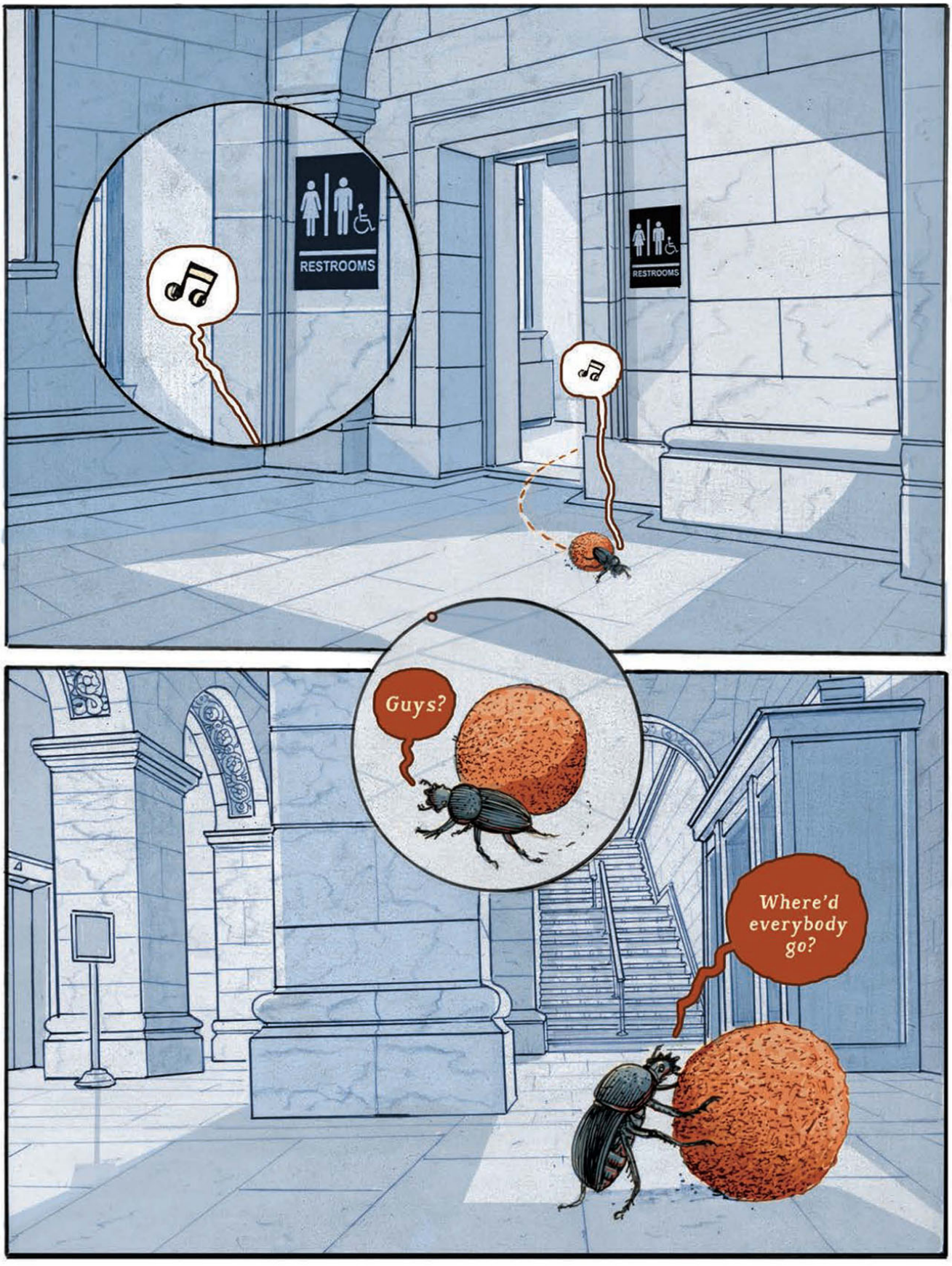
HOW MANY INSECTS CAN CLAIM *THAT*??

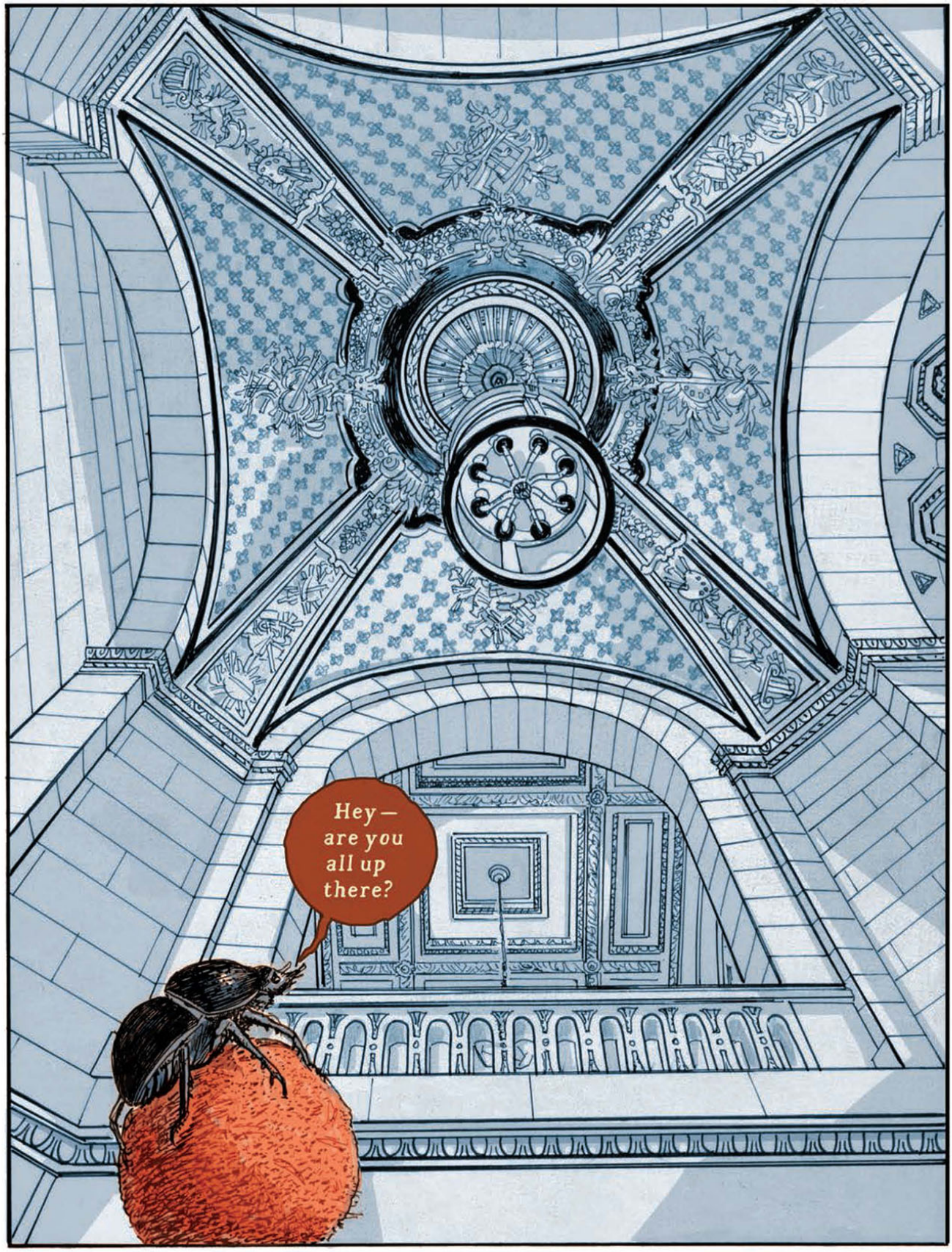
Wow — Mom was right...

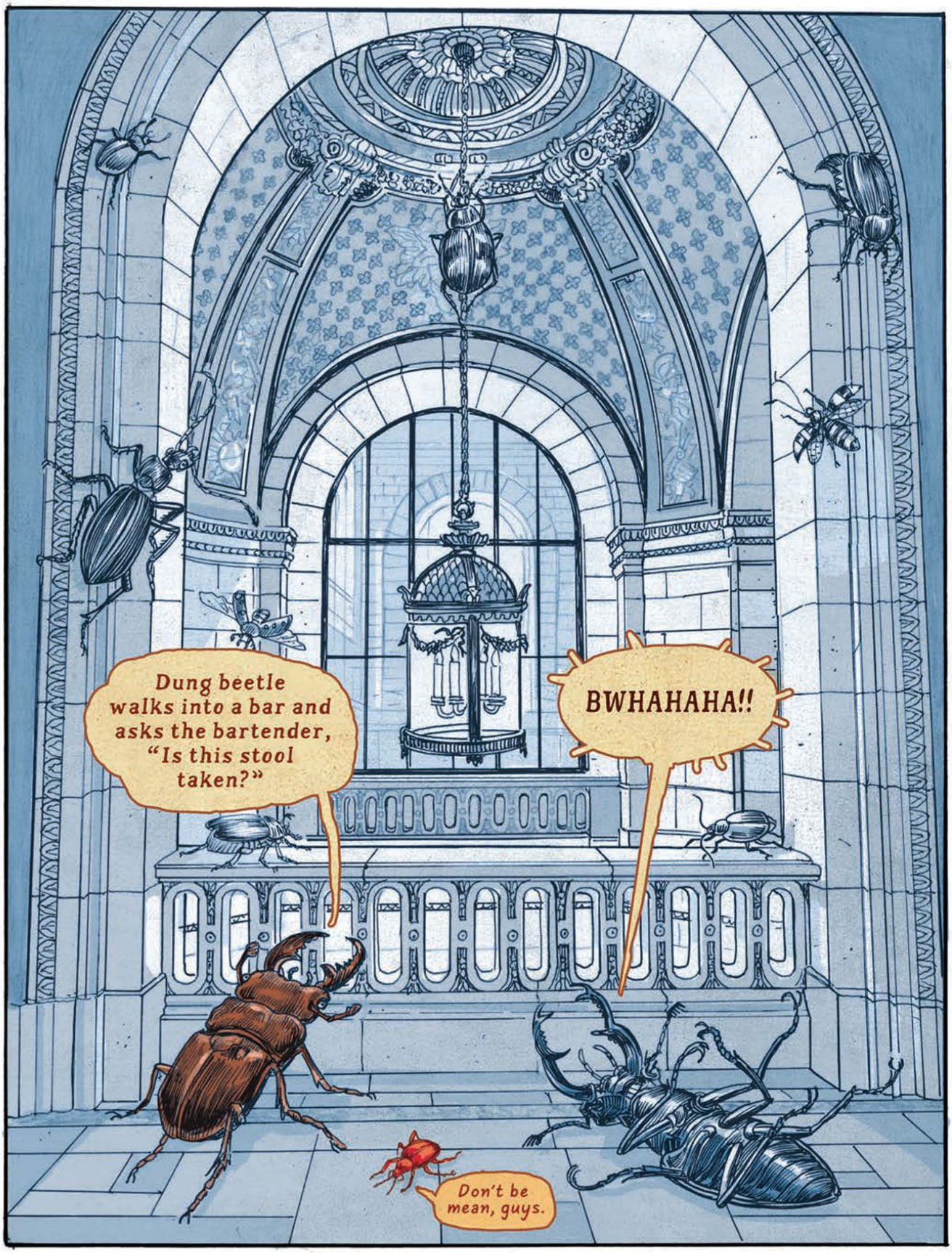
*I had no idea we were so... **significant!***


Mighty
significant!

Ancient Egyptian
Winged Scarab Beetle
Khepri Sun Disk Hieroglyphic
(circa 664–332 B.C.E.)

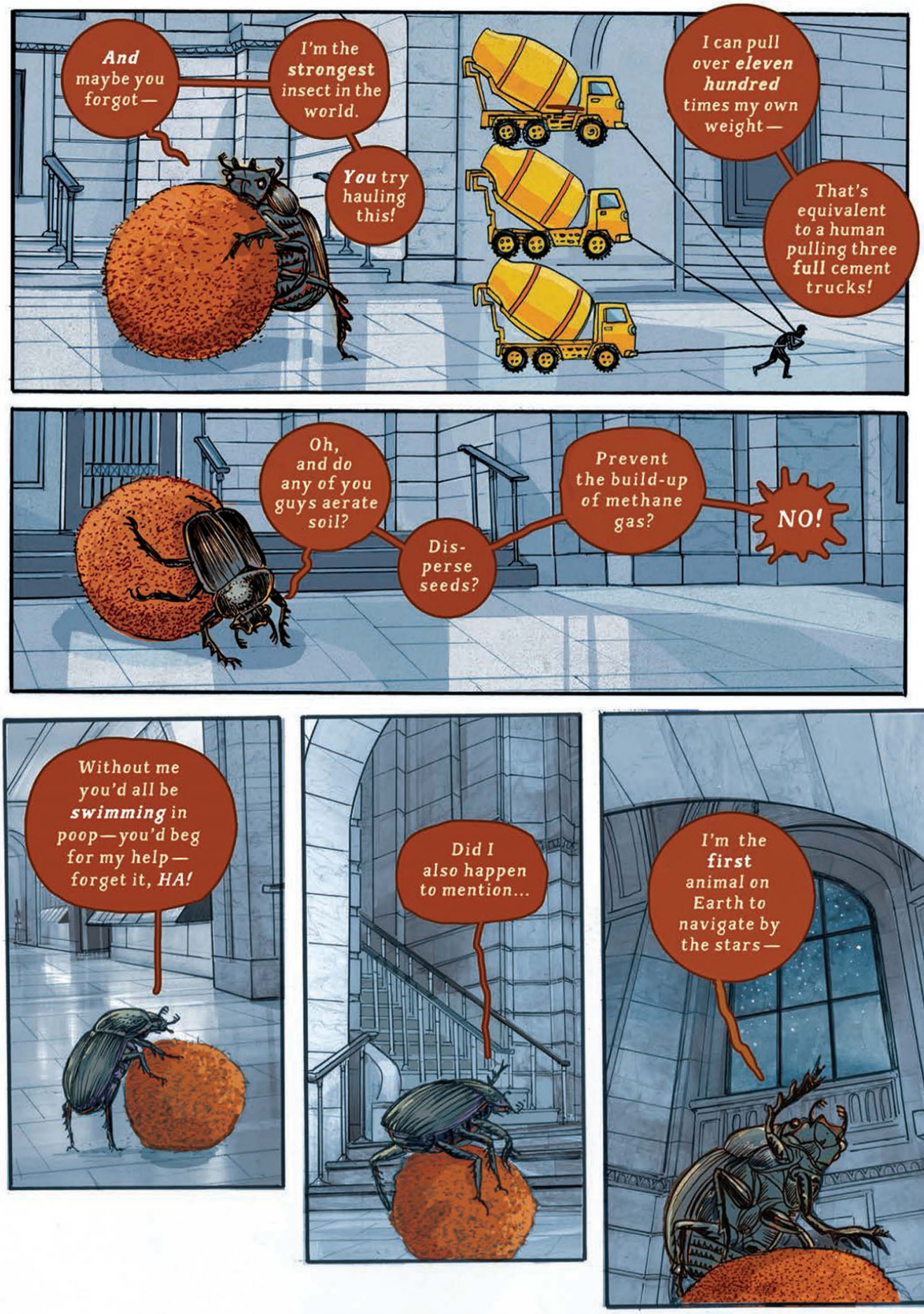

RESTROOMS
RESTROOMS
Guys?
Where'd everybody go?

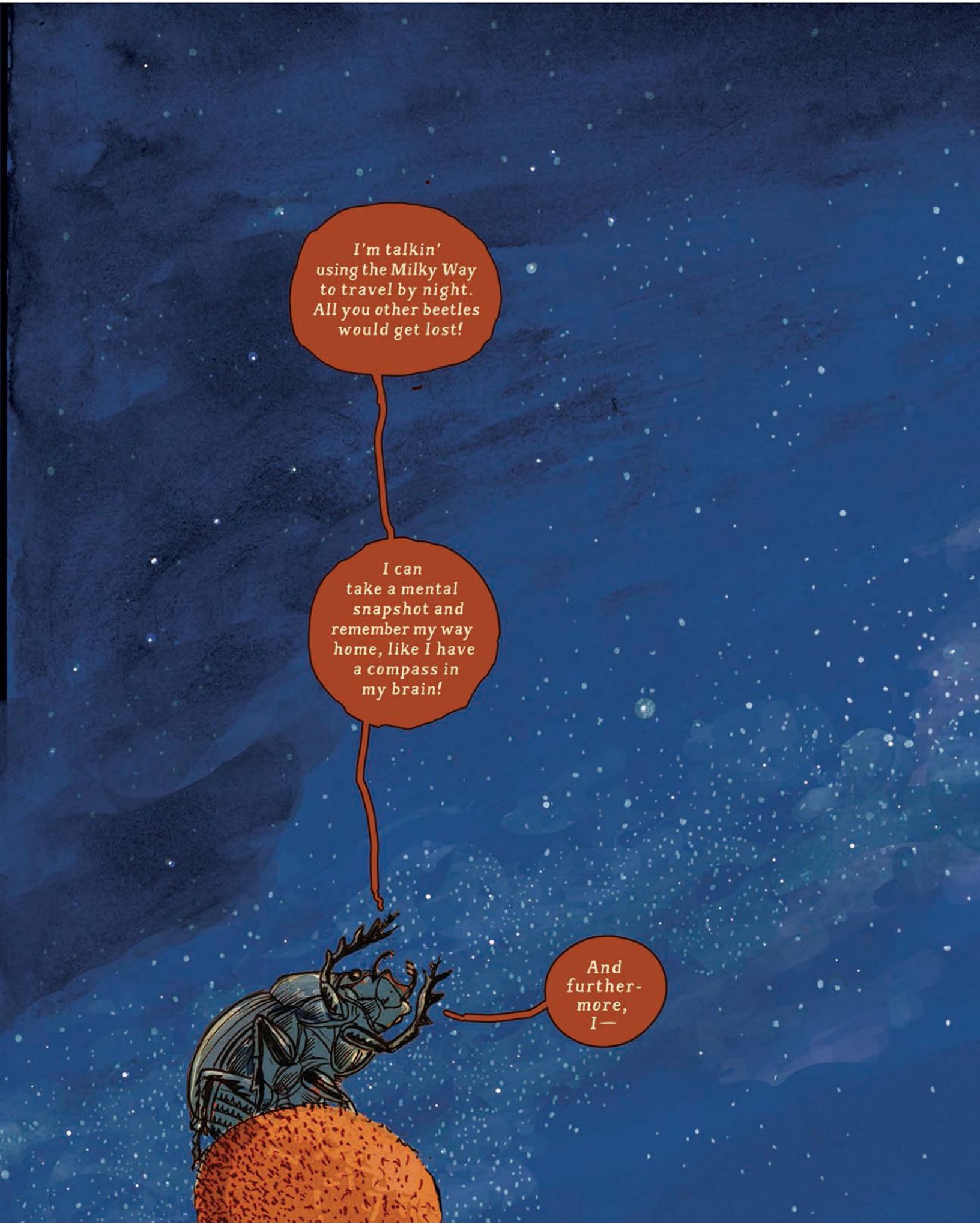

Hey—
are you
all up
there?


Dung beetle walks into a bar and asks the bartender, "Is this stool taken?"
BWHAHAHA!!
Don't be mean, guys.

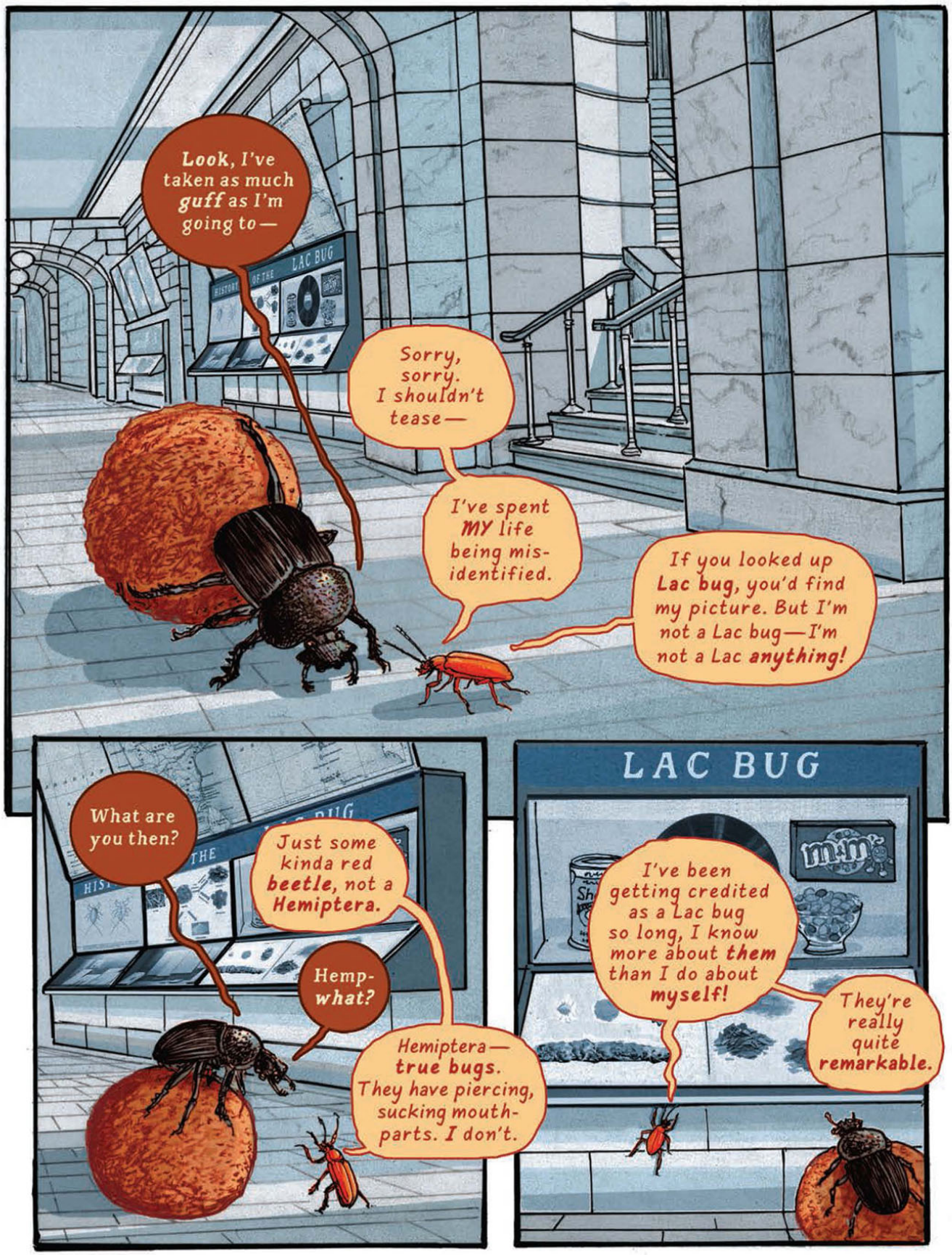
I HEARD THAT!!
Self-righteous jerks...
You don't know sh—
I've been worshipped as a GOD!

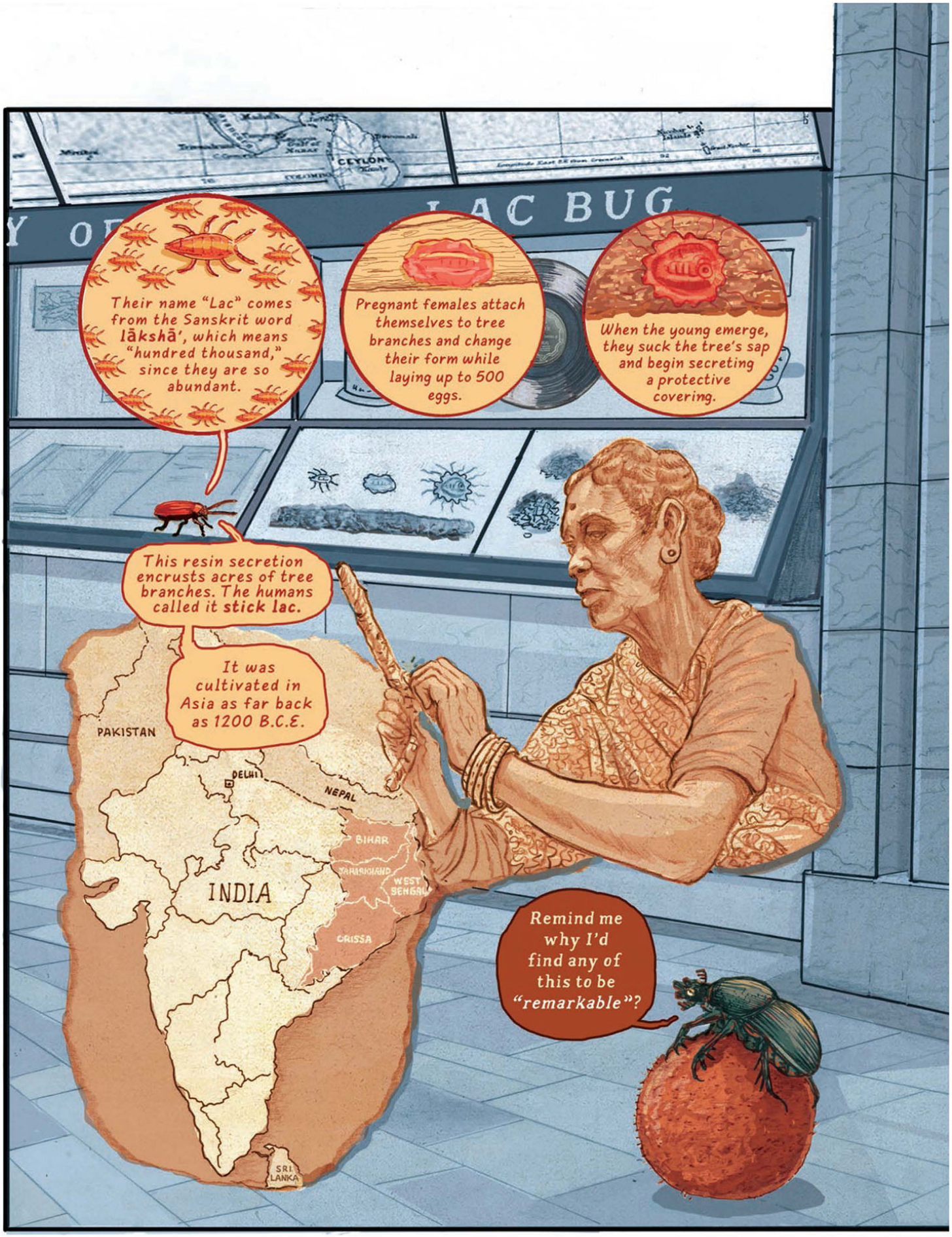
I was sacred, dammit!
Thousands of years ago the Egyptians prayed to me.
Statues honored me.
I was carved on walls.
You guys ever heard of Khepri, god of the rising sun??
That's ME! They believed I pushed the sun across the sky, carried it into the night...
then reemerged with it at dawn.
They carved jewelry in my image from ivory and gold...
and placed it in the tombs of kings.
I signified resurrection, I—
OOF I deserve respect!

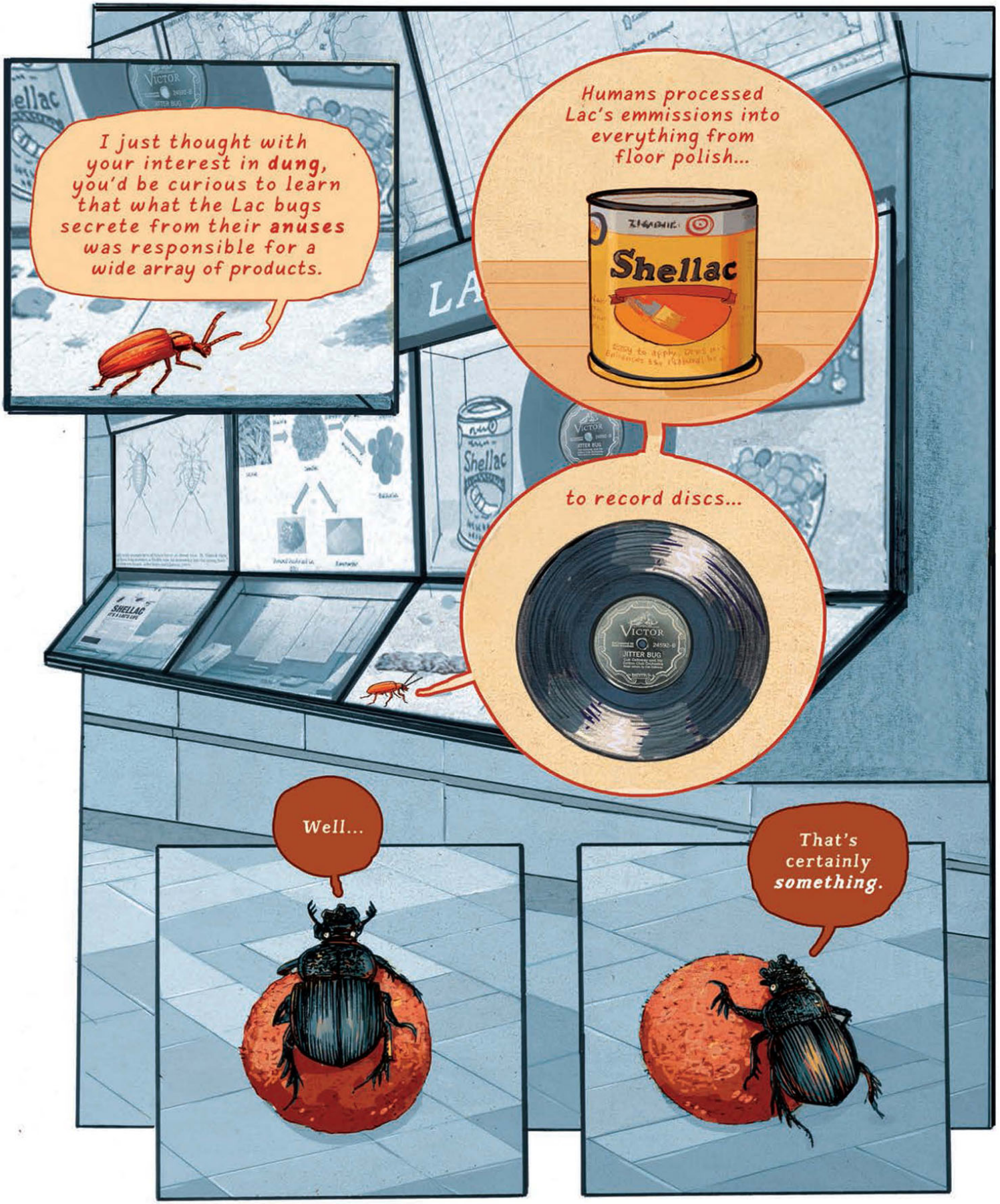

And maybe you forgot—
I'm the strongest insect in the world.
You try hauling this!
I can pull over eleven hundred times my own weight—
That's equivalent to a human pulling three full cement trucks!
Oh, and do any of you guys aerate soil?
Dis-perse seeds?
Prevent the build-up of methane gas?
NO!
Without me you'd all be swimming in poop—you'd beg for my help—forget it, HA!
Did I also happen to mention...
I'm the first animal on Earth to navigate by the stars—

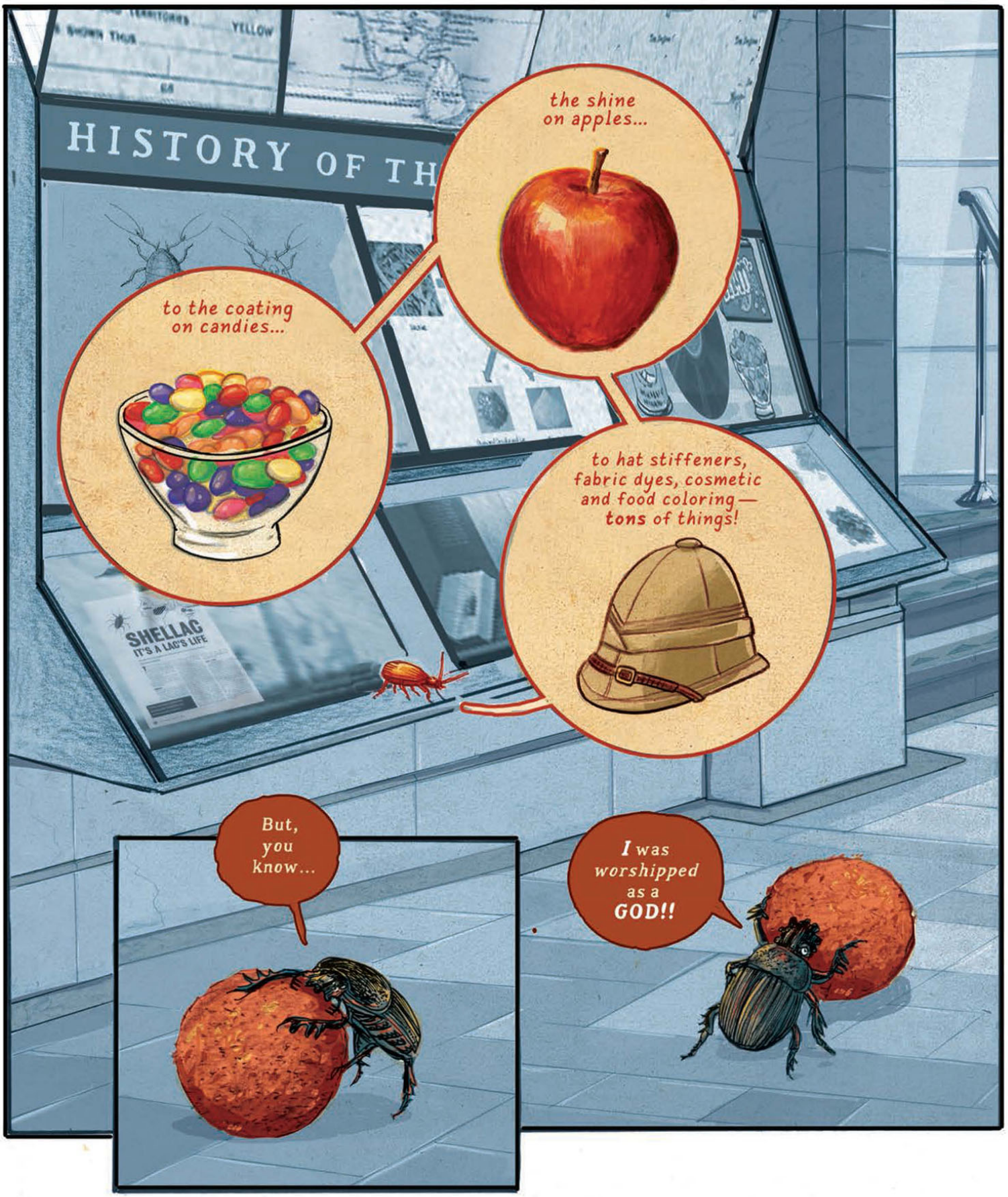

I'm talkin' using the Milky Way to travel by night. All you other beetles would get lost!
I can take a mental snapshot and remember my way home, like I have a compass in my brain!
And furthermore, I—

Wow— you're really on a roll!

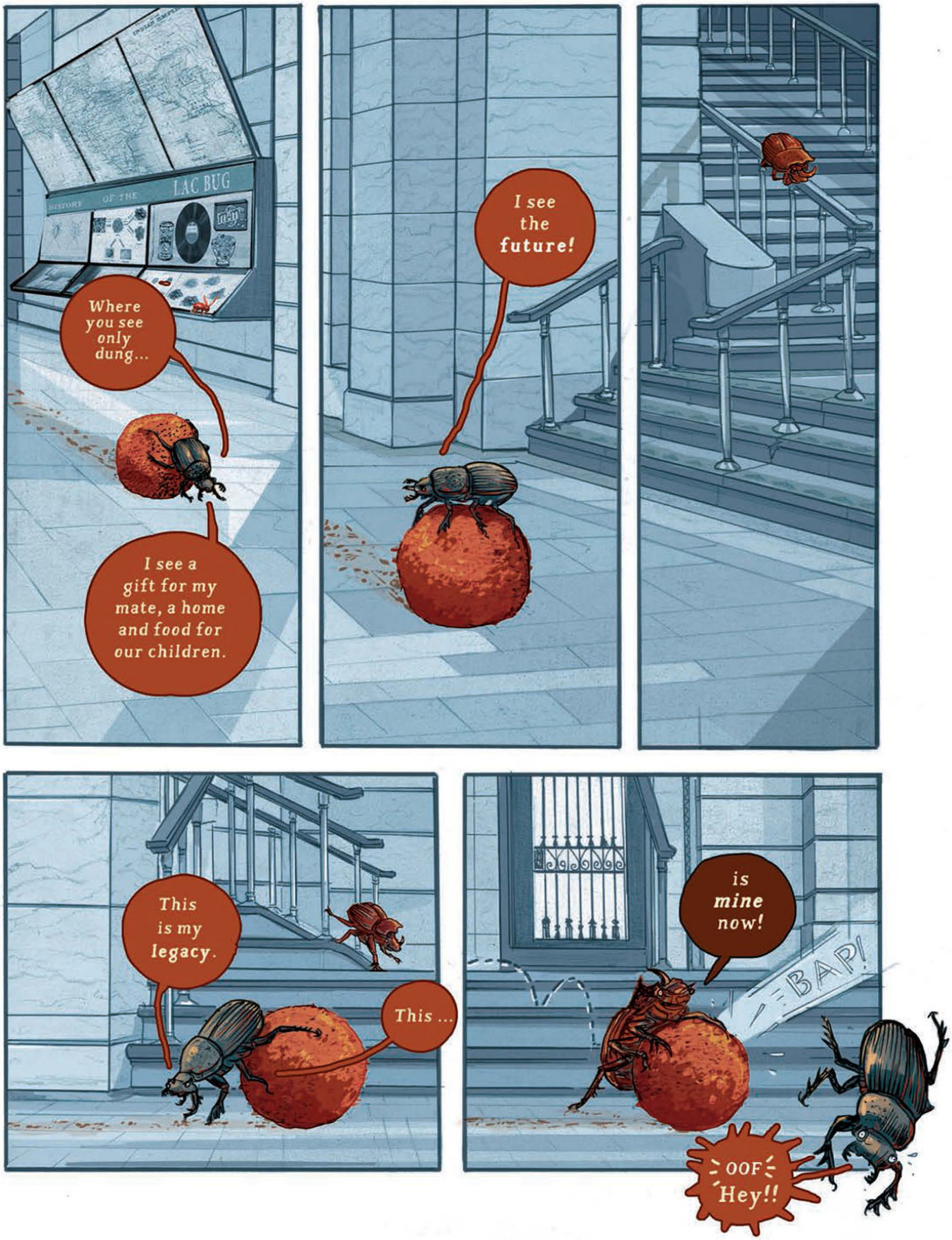

Look, I've taken as much guff as I'm going to—
Sorry, sorry. I shouldn't tease—
I've spent MY life being mis-identified.
If you looked up Lac bug, you'd find my picture. But I'm not a Lac bug—I'm not a Lac anything!
What are you then?
Just some kinda red beetle, not a Hemiptera.
Hemp-what?
Hemiptera—true bugs. They have piercing, sucking mouth-parts. I don't.
LAC BUG
I've been getting credited as a Lac bug so long, I know more about them than I do about myself!
They're really quite remarkable.

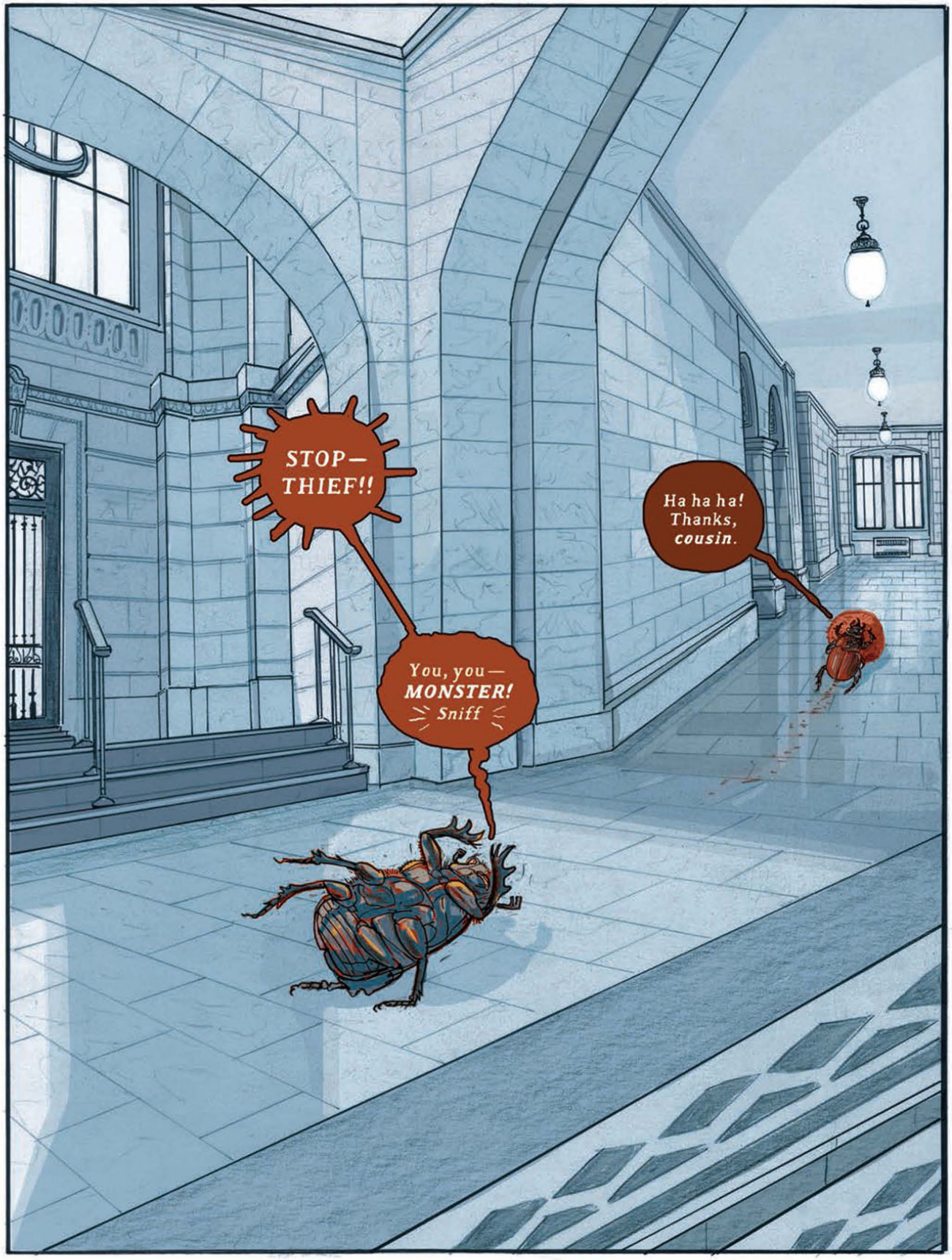

Their name "Lac" comes from the Sanskrit word lākshā', which means "hundred thousand," since they are so abundant.
Pregnant females attach themselves to tree branches and change their form while laying up to 500 eggs.
When the young emerge, they suck the tree's sap and begin secreting a protective covering.
This resin secretion encrusts acres of tree branches. The humans called it stick lac.
It was cultivated in Asia as far back as 1200 B.C.E.
Remind me why I'd find any of this to be "remarkable"?
PAKISTAN
DELHI
NEPAL
BIHAR
JHARKHAND
WEST BENGAL
INDIA
ORISSA
SRI LANKA


I just thought with your interest in dung, you'd be curious to learn that what the Lac bugs secrete from their anuses was responsible for a wide array of products.
Humans processed Lac's emmissions into everything from floor polish...
Shellac
to record discs...
VICTOR
JITTER BUG
Well...
That's certainly something.


HISTORY OF TH
YELLOW
SHOWN THUS
SHELLAC
IT'S A LAC'S LIFE
the shine on apples...
to the coating on candies...
to hat stiffeners, fabric dyes, cosmetic and food coloring— tons of things!
But, you know...
I was worshipped as a GOD!!

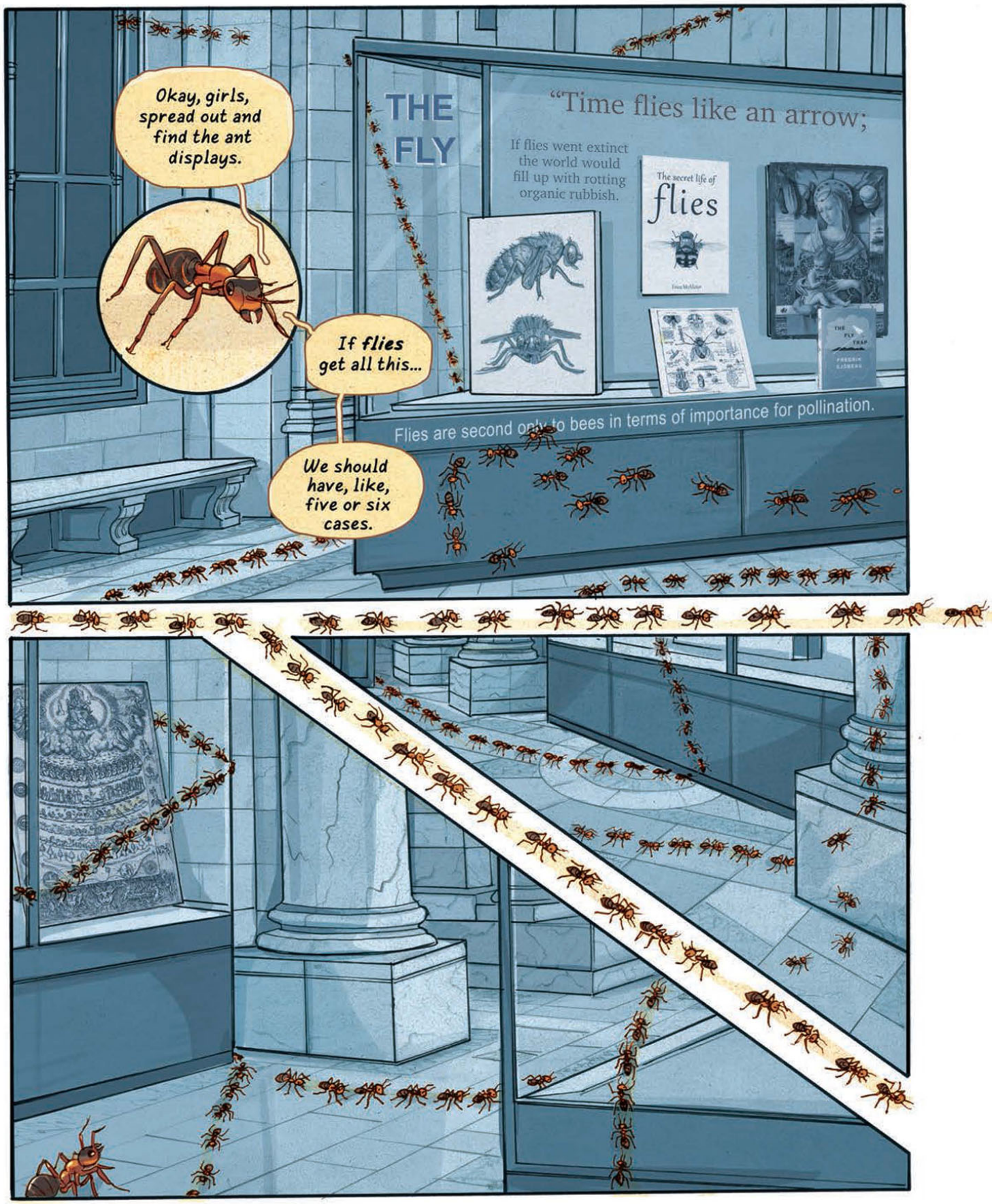
Y OF THE LAC BUG
This ball of feces is vital.
And while others may scoff...
I know my role is essential.

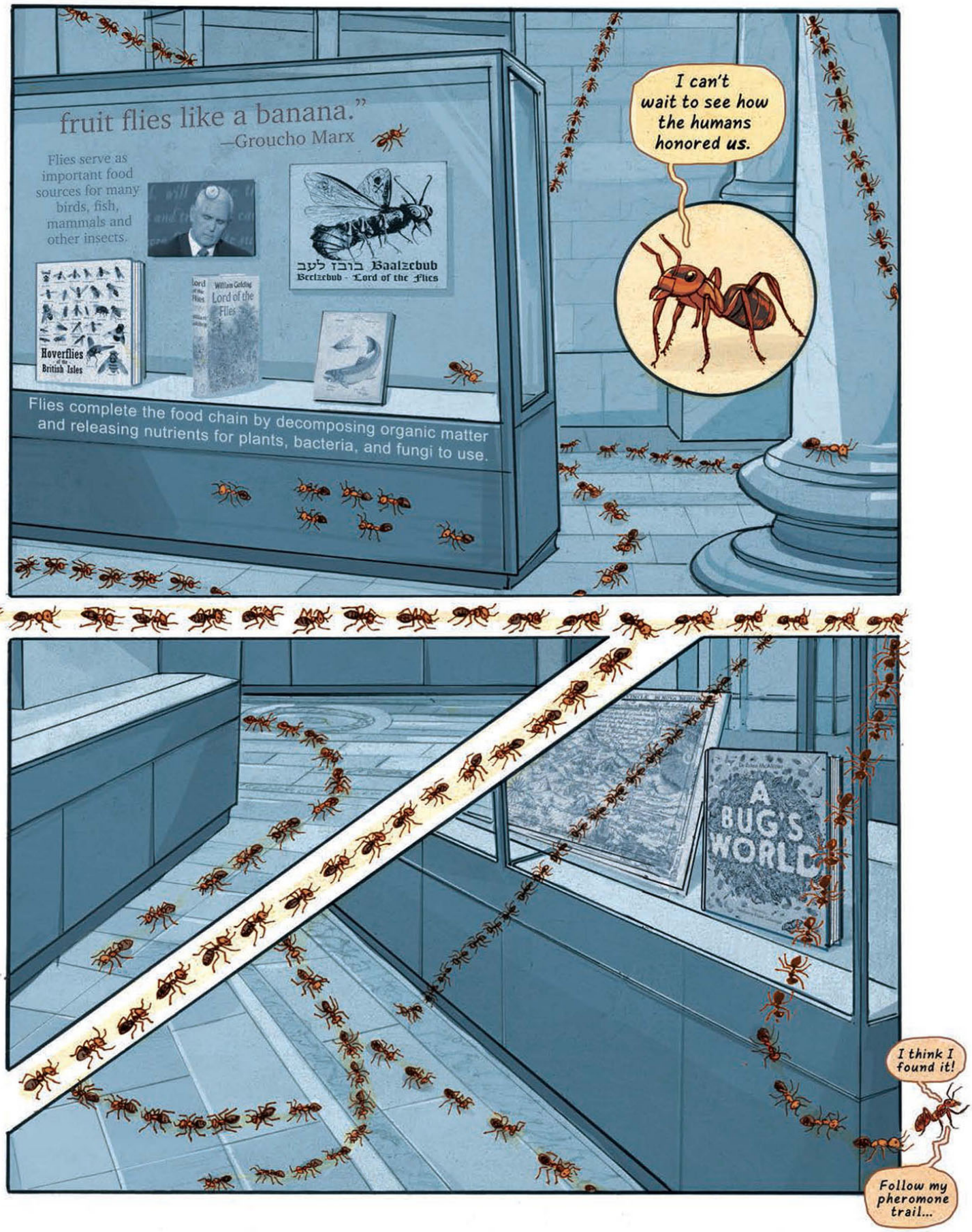

LAC BUG
Where you see only dung...
I see a gift for my mate, a home and food for our children.
I see the future!
This is my legacy.
This ...
is mine now!
BAP!
OOF
Hey!!

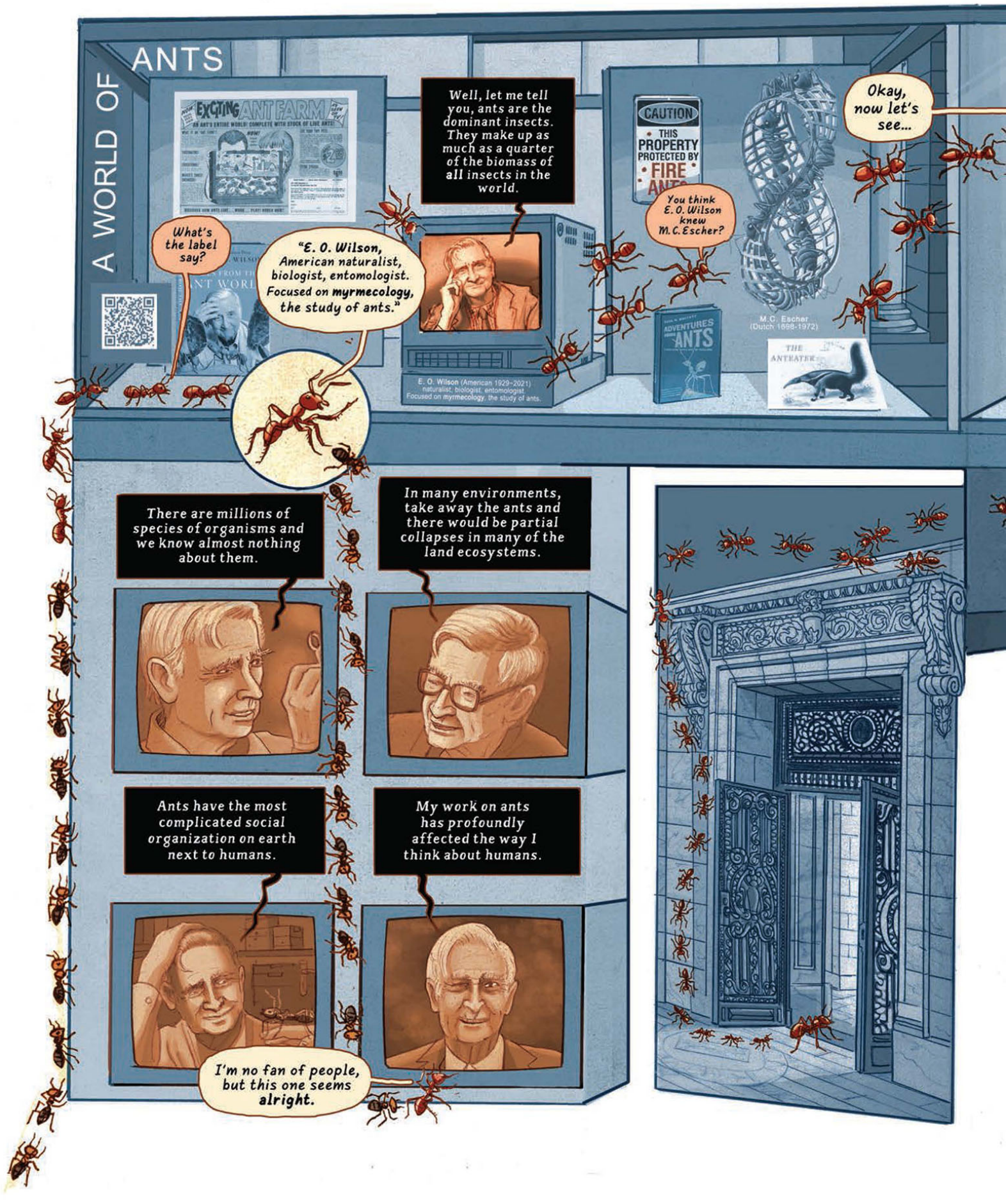

STOP—
THIEF!!
You, you—
MONSTER!
Sniff
Ha ha ha!
Thanks,
cousin.

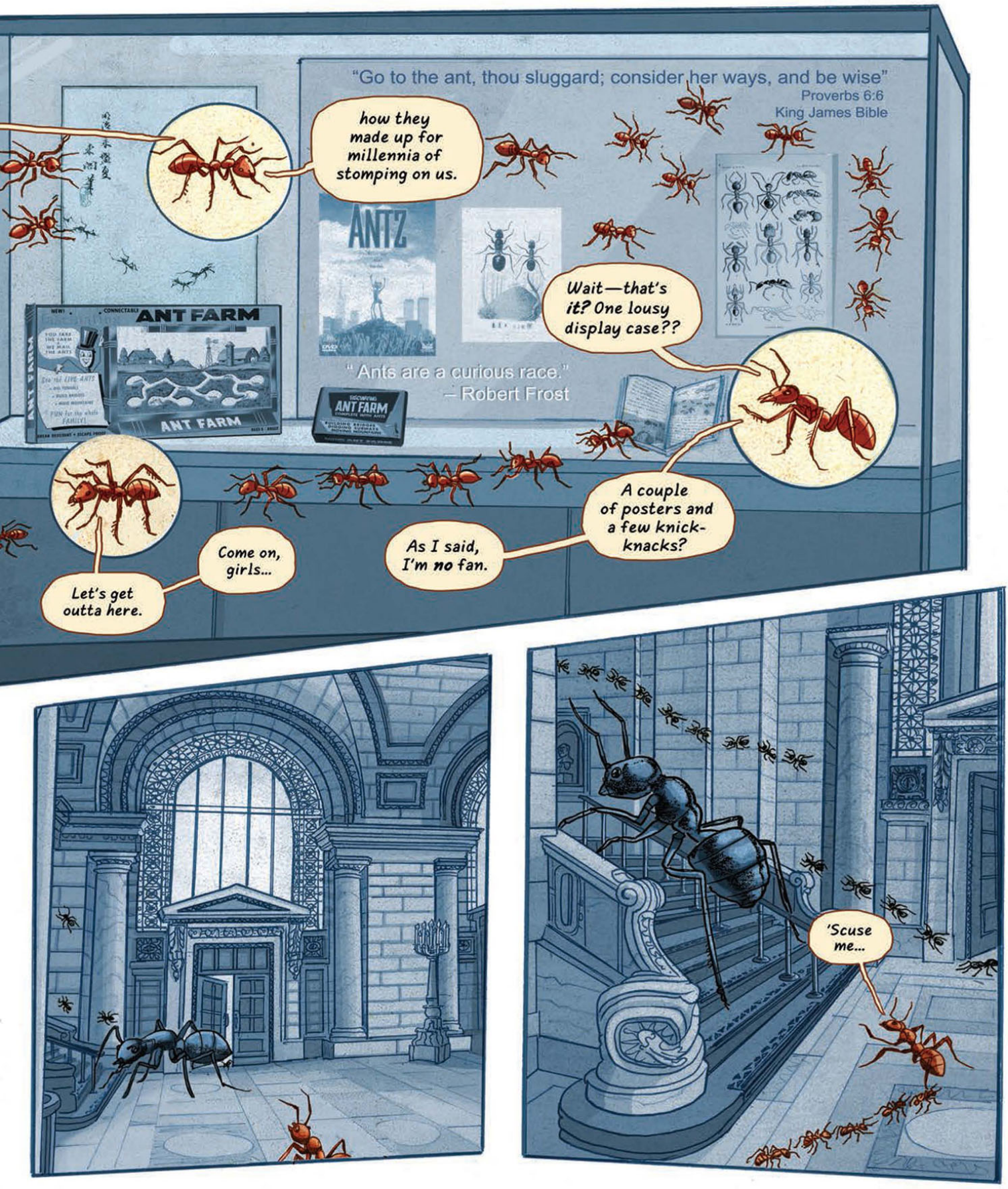
NOW! YOUR VERY OWN
EXCTING ANT FARM
AS SEEN ON TV!
AN ANT'S ENTIRE WORLD!
WHAT IS AN "ANT FARM"?
FASCINATING!
EDUCATIONAL!
WORLD'S TINIEST ENGINEERS!
NOW! YOUR VERY OWN
SEE YOUR TINY PETS . . .
ONLY $2.98
ANTS CANNOT ESCAPE FROM FARM ENCLOSURE!
EXTRA SPECIAL . . .
ONLY $6.95
MAIL TODAY . . . Money Back Guarantee! . . . No C.O.D.'s
ANT FARM
P.O. Box 20 , Rockville Centre, New York
NAME
ADDRESS
CITY
STATE
ZIP CODE
DISCOVER HOW ANTS LIVE . . . WORK . . . PLAY! ORDER NOW!

Invented in 1932 by French entomologist Charles Janet, the Ant Farm was a familiar toy sold by mail order in comic books in the 1950s and 1960s.

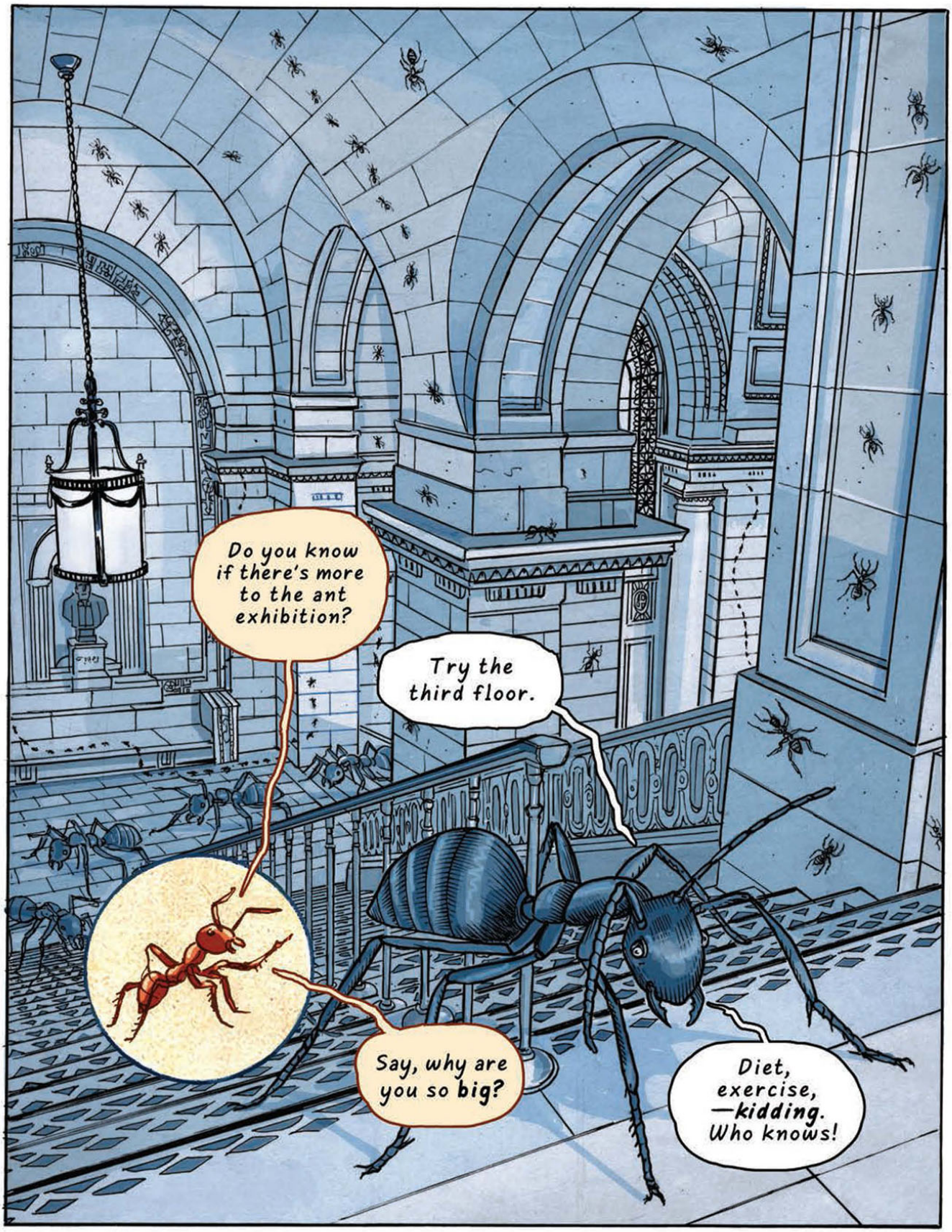

Okay, girls, spread out and find the ant displays.
If flies get all this...
We should have, like, five or six cases.
THE FLY
"Time flies like an arrow;
If flies went extinct the world would fill up with rotting organic rubbish.
The secret life of flies
Flies are second only to bees in terms of importance for pollination.

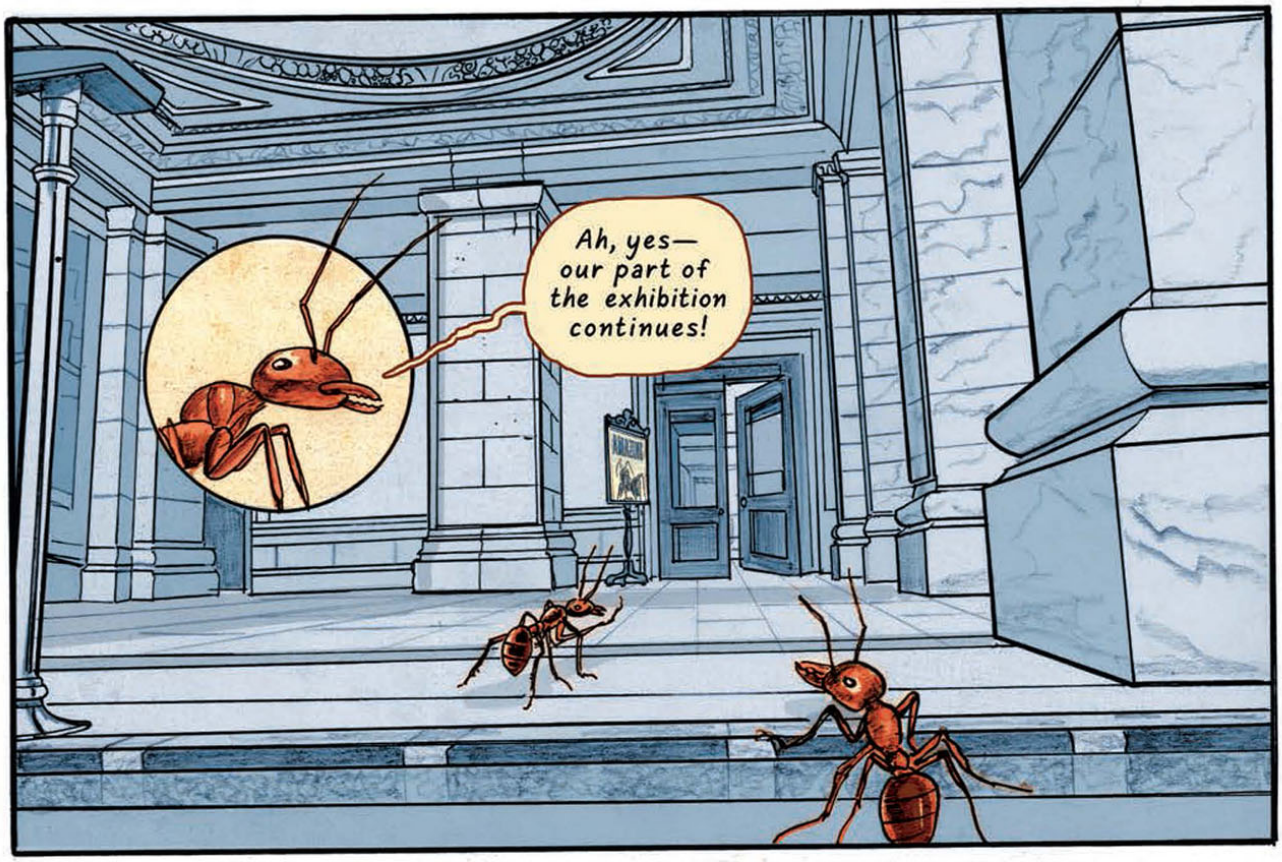

fruit flies like a banana."
—Groucho Marx
Flies serve as important food sources for many birds, fish, mammals and other insects.
Hoverflies of the British Isles
William Golding Lord of the Flies
בובז לעב Baalzebub
Beelzebub - Lord of the Flies
Flies complete the food chain by decomposing organic matter and releasing nutrients for plants, bacteria, and fungi to use.
I can't wait to see how the humans honored us.
A BUG'S WORLD
I think I found it!
Follow my pheromone trail...

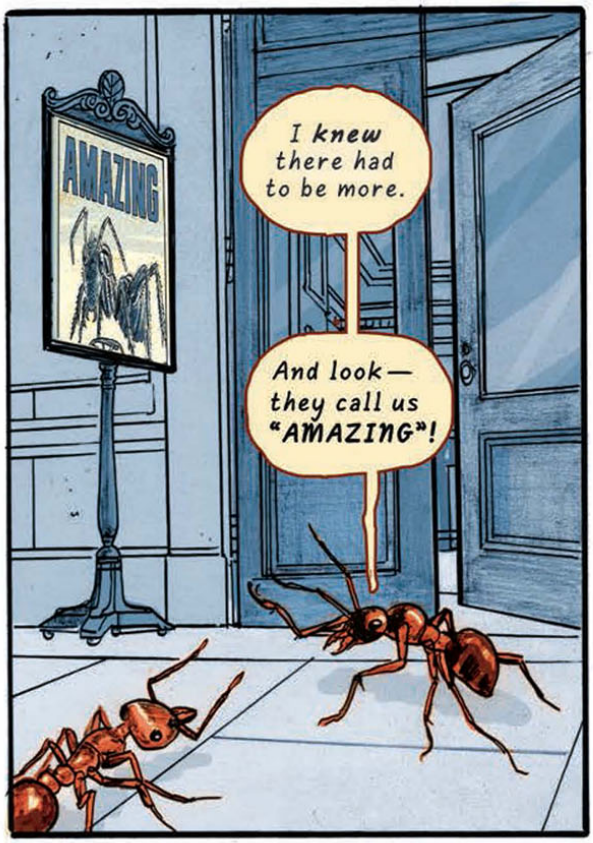

A WORLD OF ANTS
EXCITING ANT FARM
What's the label say?
"E. O. Wilson, American naturalist, biologist, entomologist. Focused on myrmecology, the study of ants."
Well, let me tell you, ants are the dominant insects. They make up as much as a quarter of the biomass of all insects in the world.
E. O. Wilson (American 1929–2021) naturalist, biologist, entomologist Focused on myrmecology, the study of ants.
CAUTION
THIS PROPERTY PROTECTED BY
FIRE
You think E. O. Wilson knew M. C. Escher?
Okay, now let's see...
M.C. Escher (Dutch 1898-1972)
ADVENTURES AMONG ANTS
THE ANTEATER
There are millions of species of organisms and we know almost nothing about them.
In many environments, take away the ants and there would be partial collapses in many of the land ecosystems.
Ants have the most complicated social organization on earth next to humans.
My work on ants has profoundly affected the way I think about humans.
I'm no fan of people, but this one seems alright.


"Go to the ant, thou sluggard; consider her ways, and be wise"
Proverbs 6:6
King James Bible
how they made up for millennia of stomping on us.
ANTZ
"Ants are a curious race."
– Robert Frost
Wait—that's it? One lousy display case??
A couple of posters and a few knick-knacks?
As I said, I'm no fan.
Come on, girls...
Let's get outta here.

'Scuse me...

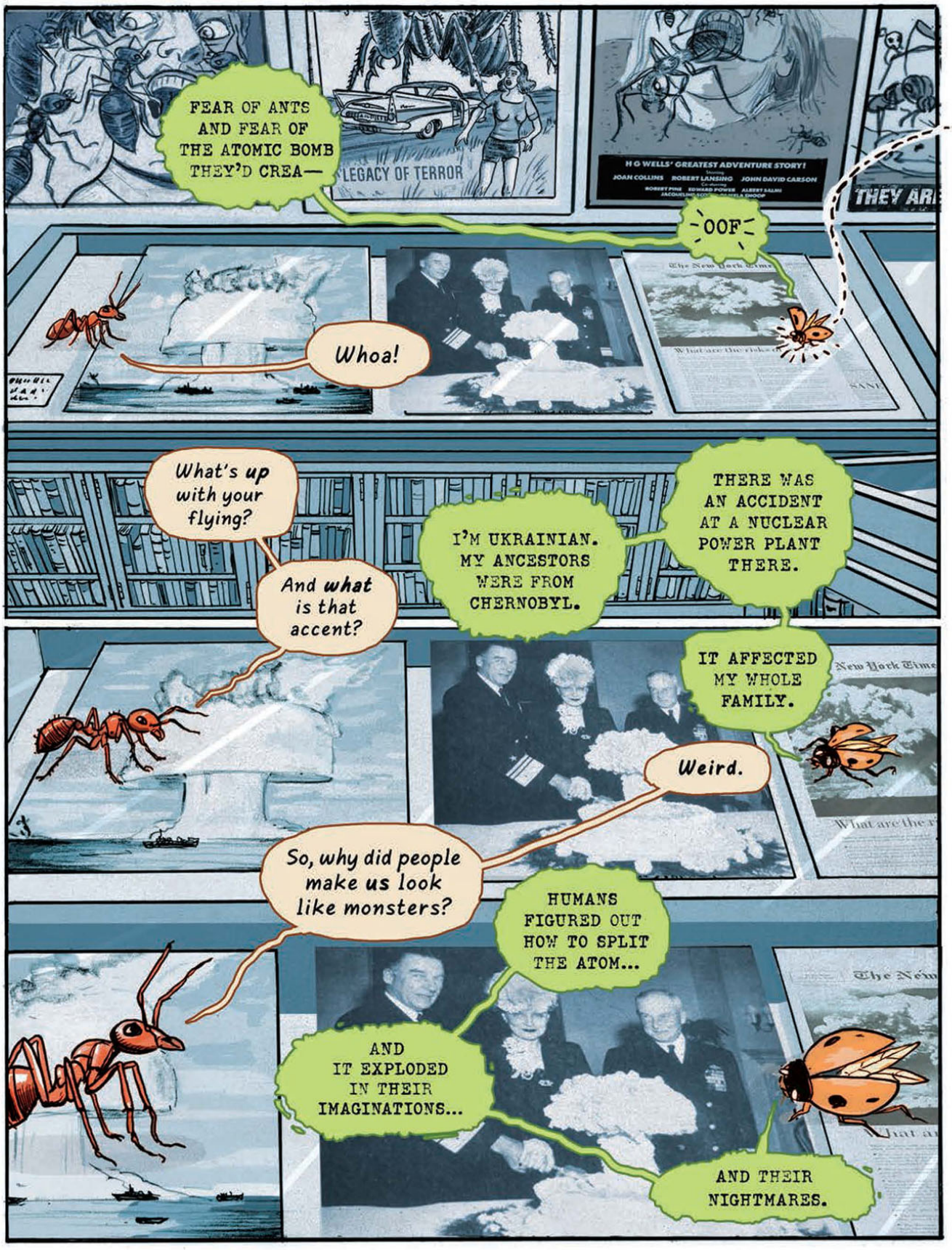

Do you know if there's more to the ant exhibition?
Try the third floor.
Say, why are you so **big**?
Diet, exercise, —***kidding***. Who knows!

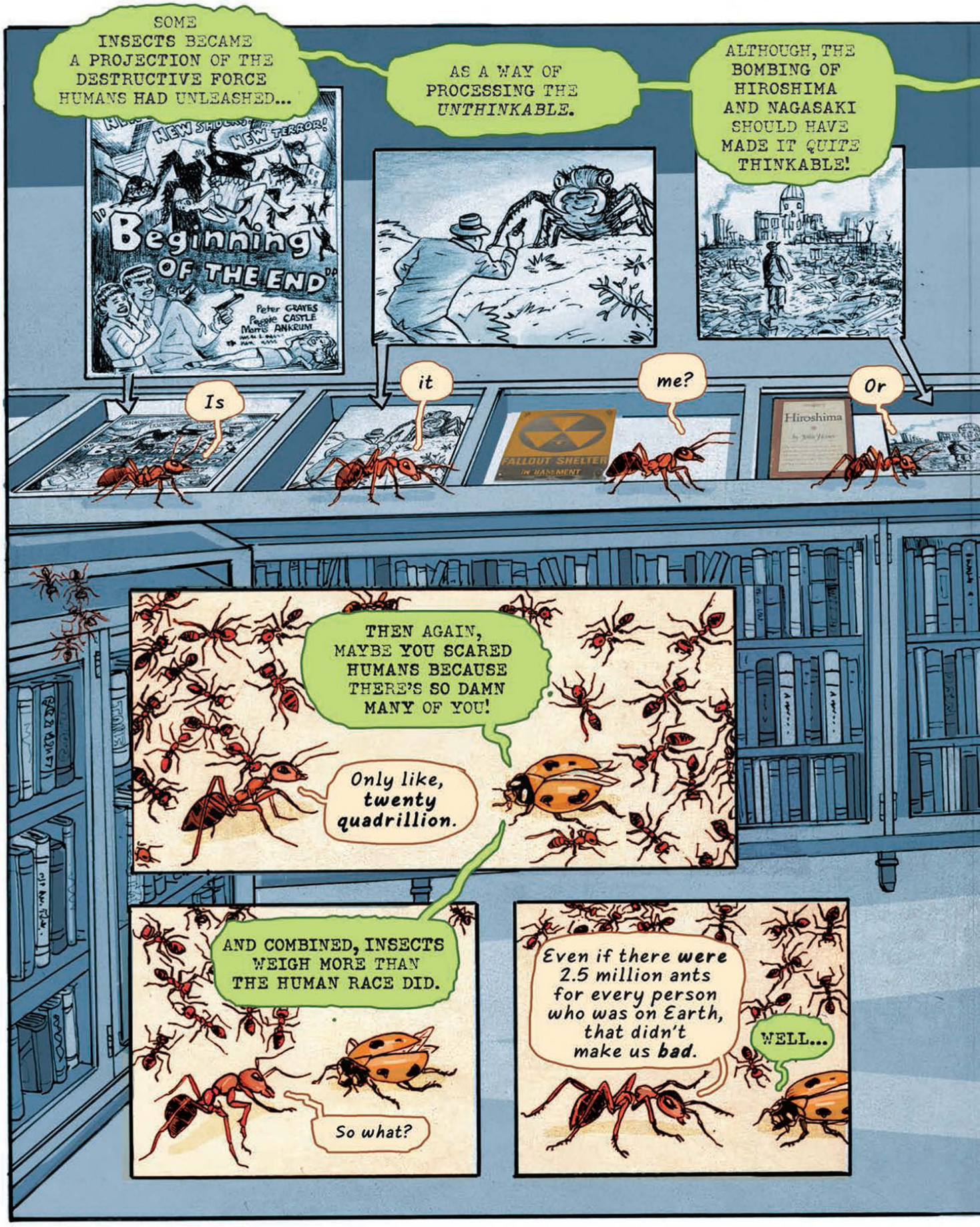

Ah, yes— our part of the exhibition continues!

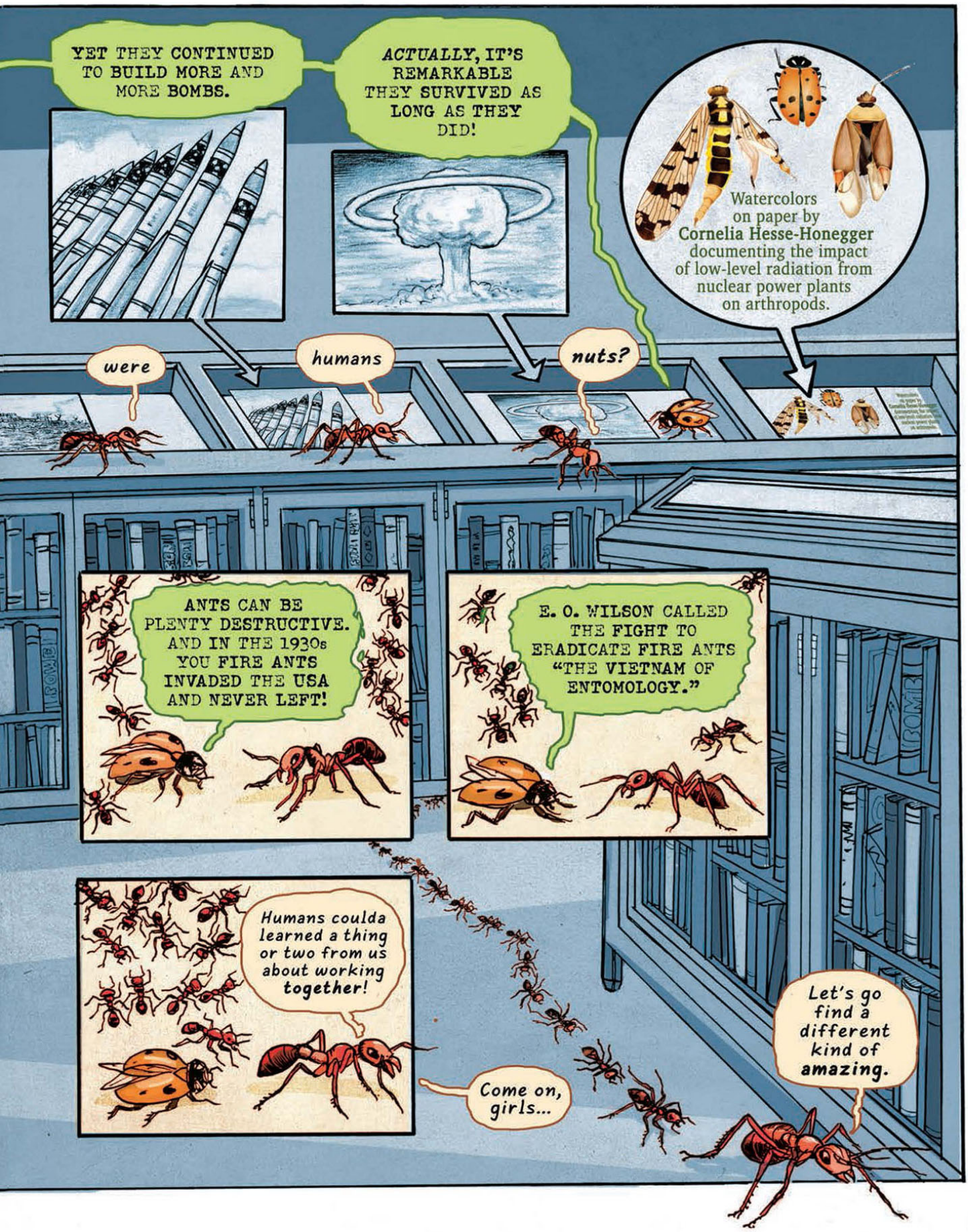

AMAZING
I knew there had to be more.
And look— they call us "AMAZING"!

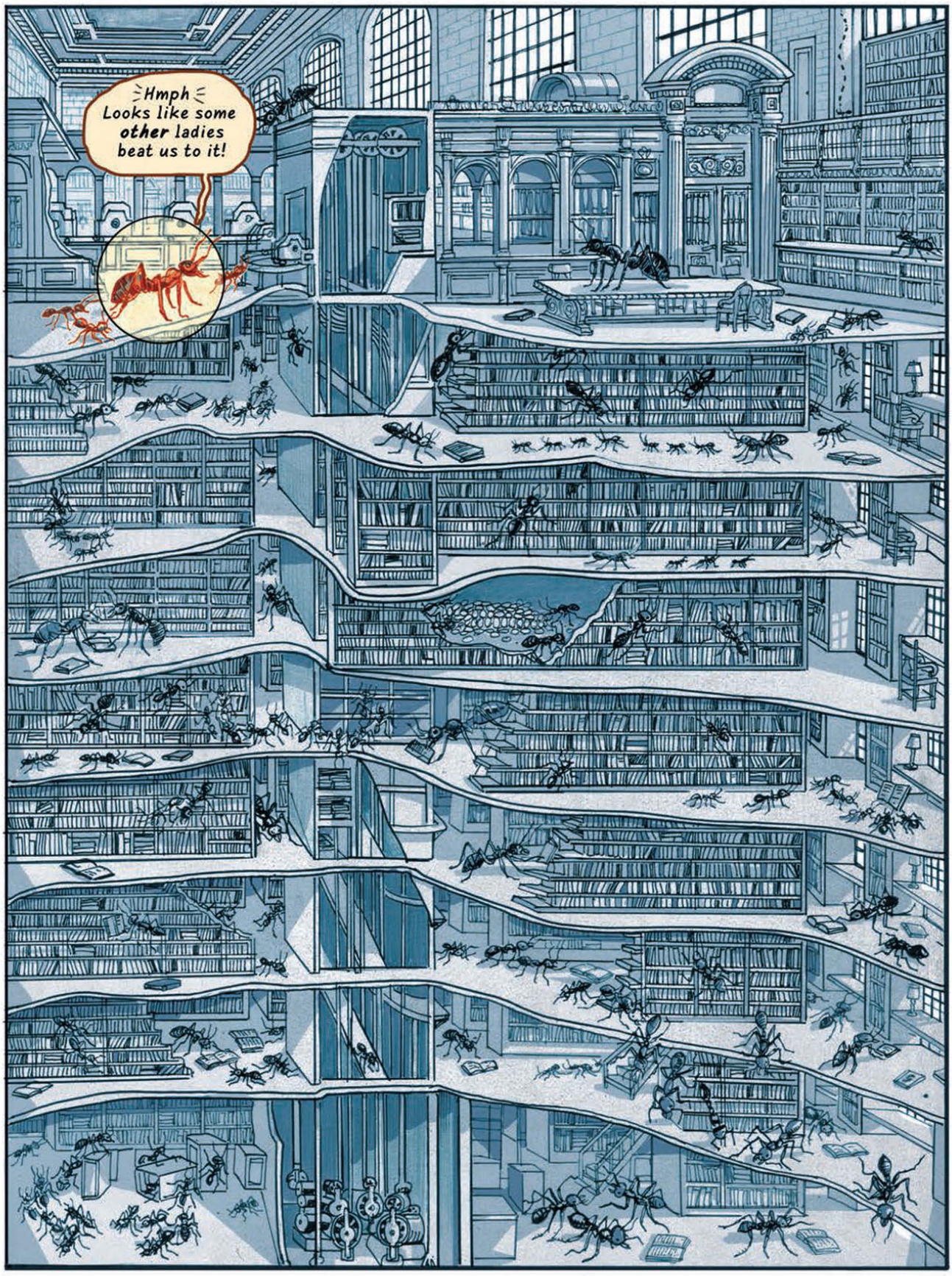
ANTS
Maybe I've judged humans too harshly.

MONSTER ANT
AMAZING STORIES QUARTERLY
AMAZING
SCIENCE FICTION STORIES
LEGACY OF TERROR
EMPIRE OF THE ANTS
KILLER ANTS
FEAR.
THEY ARE COMING FOR YOU
Amazing?? This is f—ing horrifying.
What the hell is this exhibit about??
Mommy, I'm scared.
THE INCREDIBLE ALIENS WERE EVERYWHERE WATCHING & WAITING. A WORLD INVADED BY GIANT ANTS
FIENDS
"THEM"
AN ENDLESS TERROR! A NAMELESS HORROR!
STRANDED IN A LOST WORLD OF GIGANTIC INSECTS!
THE WORLD OF THE GIANT ANTS


FEAR OF ANTS AND FEAR OF THE ATOMIC BOMB THEY'D CREA—
LEGACY OF TERROR
H G WELLS' GREATEST ADVENTURE STORY!
OOF
Whoa!
What's up with your flying?
And what is that accent?
I'M UKRAINIAN. MY ANCESTORS WERE FROM CHERNOBYL.
THERE WAS AN ACCIDENT AT A NUCLEAR POWER PLANT THERE.
IT AFFECTED MY WHOLE FAMILY.
Weird.
So, why did people make us look like monsters?
HUMANS FIGURED OUT HOW TO SPLIT THE ATOM...
AND IT EXPLODED IN THEIR IMAGINATIONS...
AND THEIR NIGHTMARES.


SOME INSECTS BECAME A PROJECTION OF THE DESTRUCTIVE FORCE HUMANS HAD UNLEASHED...
AS A WAY OF PROCESSING THE *UNTHINKABLE.*
ALTHOUGH, THE BOMBING OF HIROSHIMA AND NAGASAKI SHOULD HAVE MADE IT *QUITE* THINKABLE!
NEW TERROR!
Beginning OF THE END
Peter GRAVES
Peggie CASTLE
Morris ANKRUM
Is
it
me?
Or
FALLOUT SHELTER
IN BASEMENT
Hiroshima
THEN AGAIN, MAYBE YOU SCARED HUMANS BECAUSE THERE'S SO DAMN MANY OF YOU!
Only like, ***twenty quadrillion.***
AND COMBINED, INSECTS WEIGH MORE THAN THE HUMAN RACE DID.
So what?
Even if there ***were*** *2.5 million ants for every person who was on Earth, that didn't make us* ***bad.***
WELL...


YET THEY CONTINUED TO BUILD MORE AND MORE BOMBS.
ACTUALLY, IT'S REMARKABLE THEY SURVIVED AS LONG AS THEY DID!
Watercolors on paper by Cornelia Hesse-Honegger documenting the impact of low-level radiation from nuclear power plants on arthropods.
were
humans
nuts?
ANTS CAN BE PLENTY DESTRUCTIVE. AND IN THE 1930s YOU FIRE ANTS INVADED THE USA AND NEVER LEFT!
E. O. WILSON CALLED THE FIGHT TO ERADICATE FIRE ANTS "THE VIETNAM OF ENTOMOLOGY."
Humans coulda learned a thing or two from us about working together!
Come on, girls...
Let's go find a different kind of amazing.

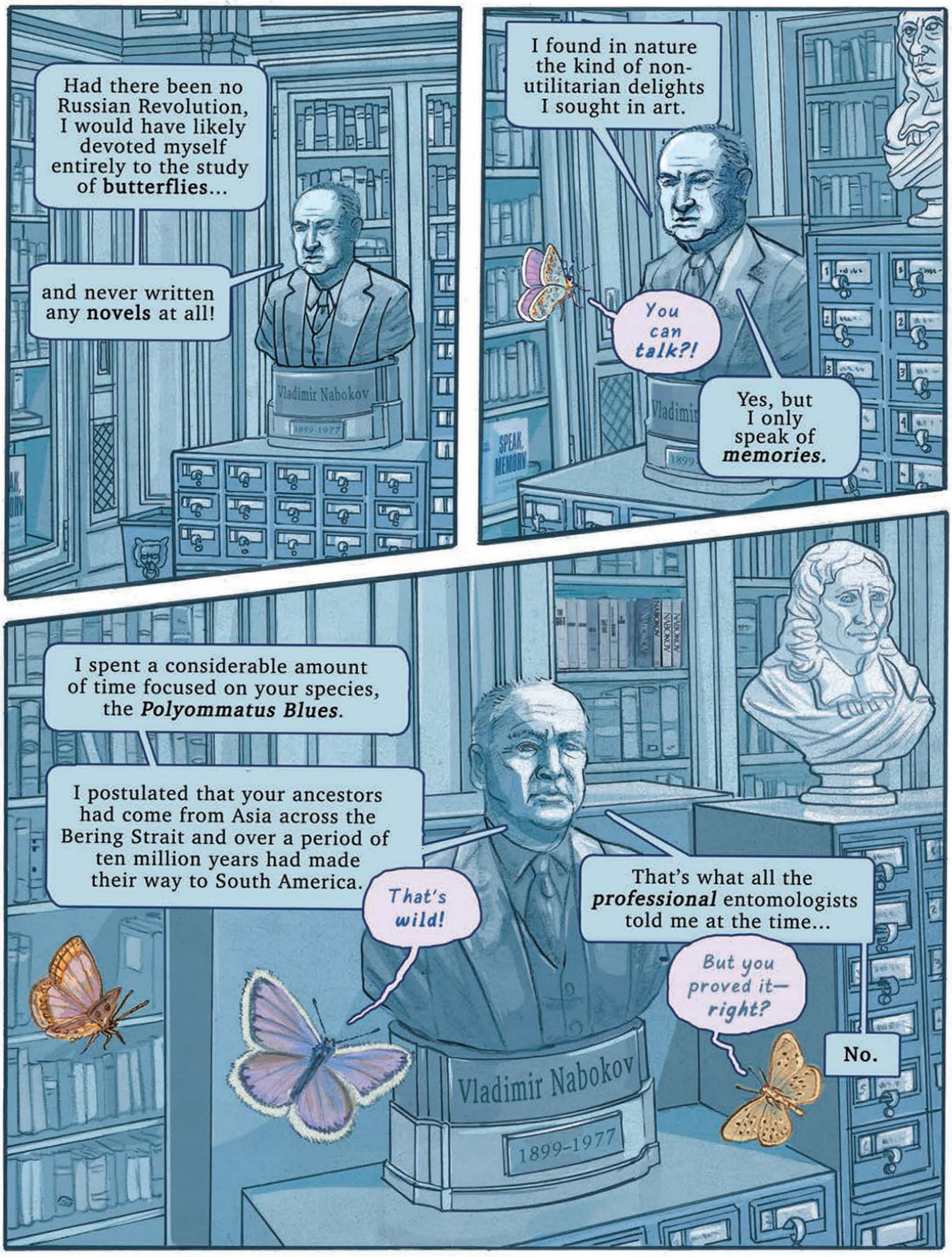

Hmph
Looks like some other ladies beat us to it!

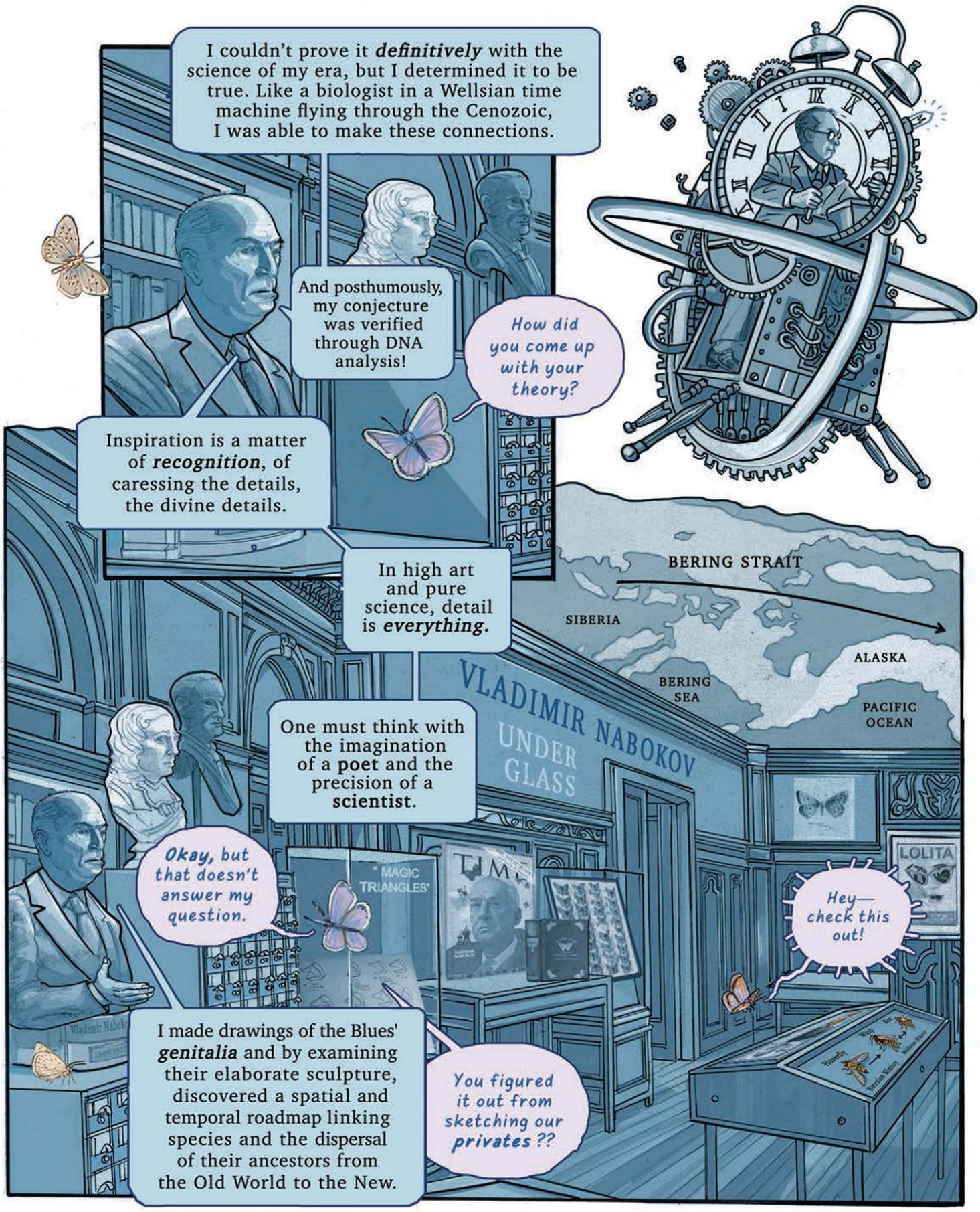
FRANZ KAFKA
DIE VERWANDLUNG
DER JÜNGSTE TAG • 22/23
KURT WOLFF VERLAG · LEIPZIG
The Metamorphosis
oke one morning from
lf transformed in his bed into a
lying on his hard, as it were
when he lifted his head a little
brown belly divided into
of which the bed quilt could
d was about to slide off com-
s, which were pitifully thin
ulk,
helplessly before
e? he thought. It was no
r human bedroom,
etween the four familiar
ich a collection of cloth
read out—Samsa was a
picture which he had
magazine and put into
dy, with a fur cap on
d holding out to the
ich the whole of her

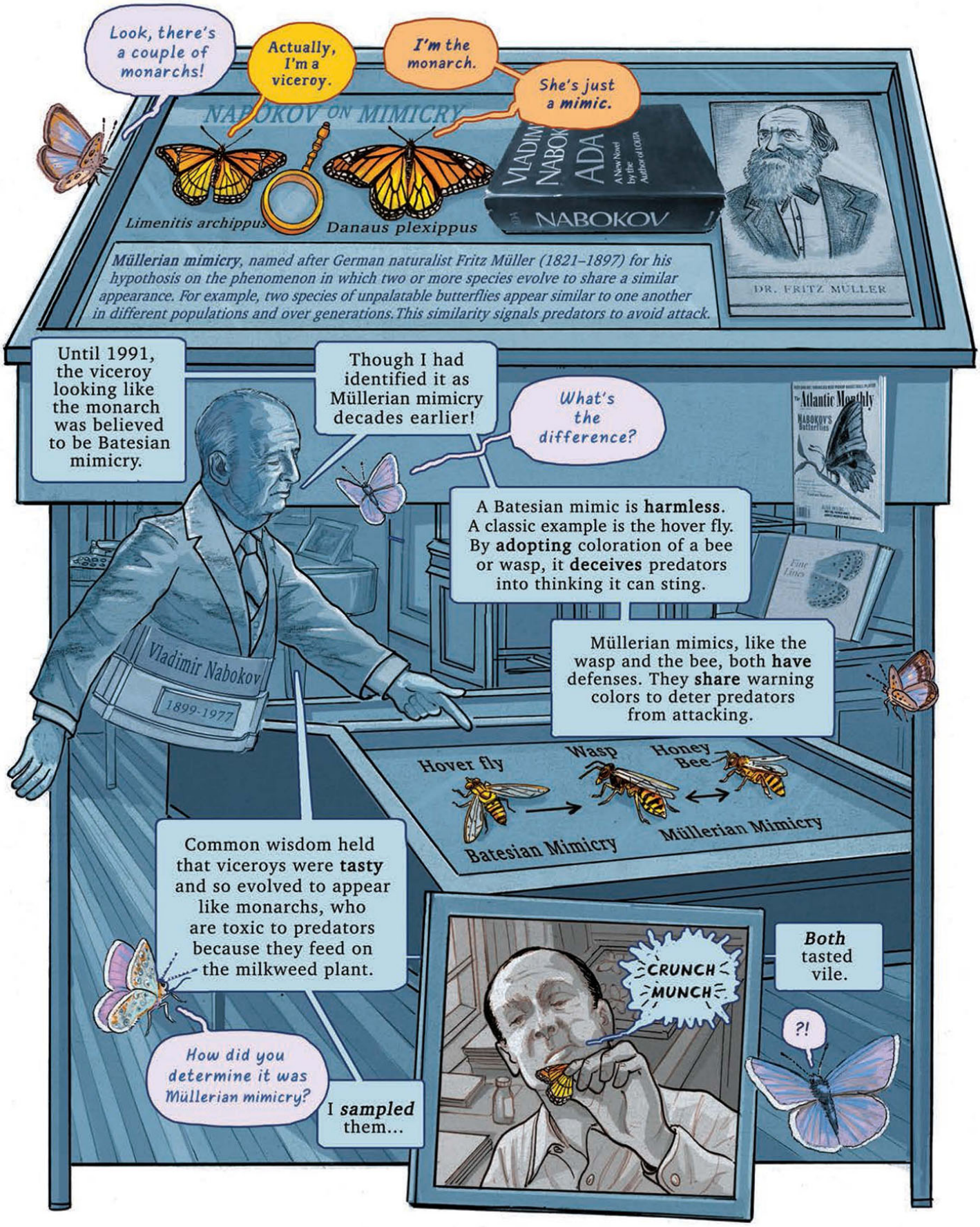
The Metamorphosis
First edition 1915
Franz Kafka
(1883-1924)
Austro-Hungarian
Empire

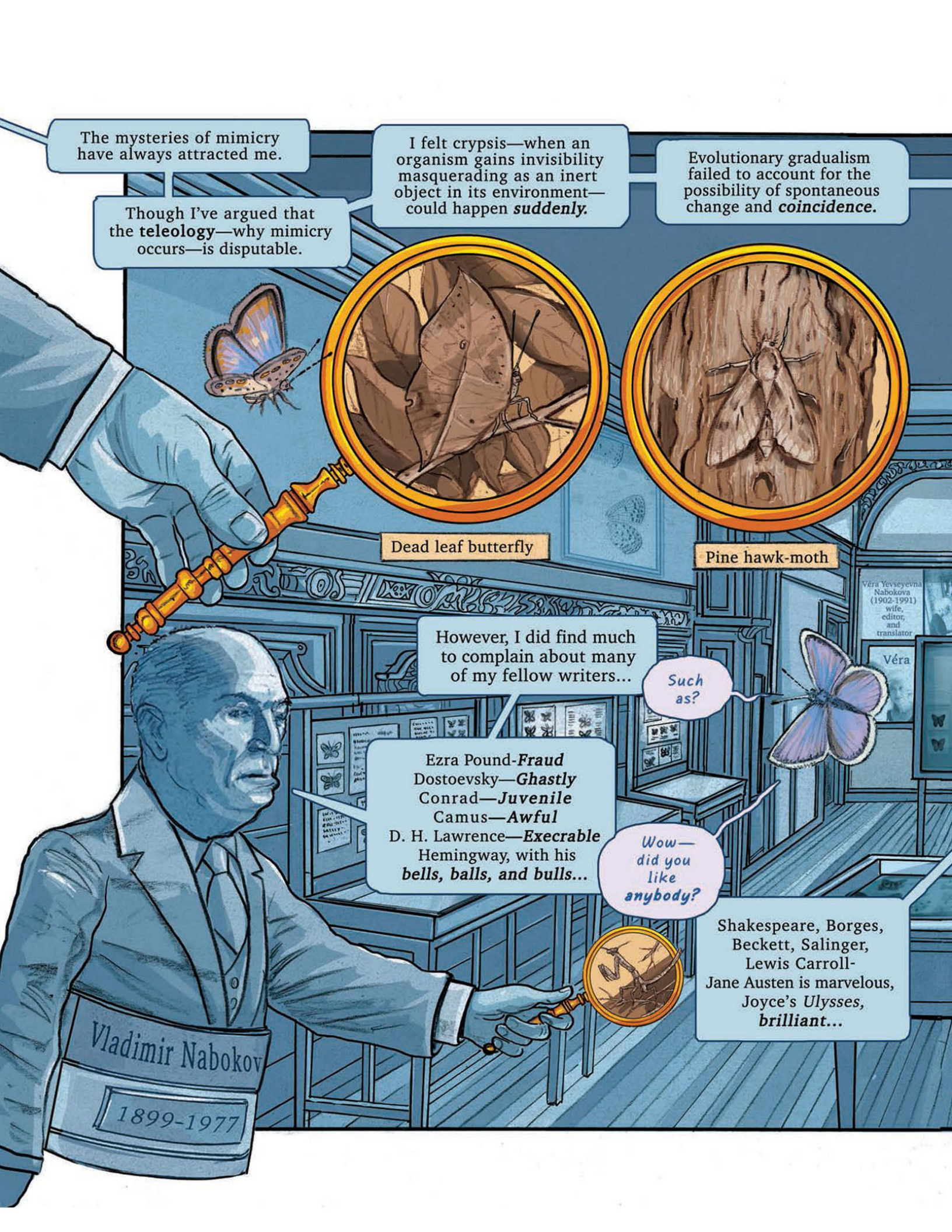
The Metamorphosis
Annotated edition
Vladimir Nabokov
(1899-1977)
Russia

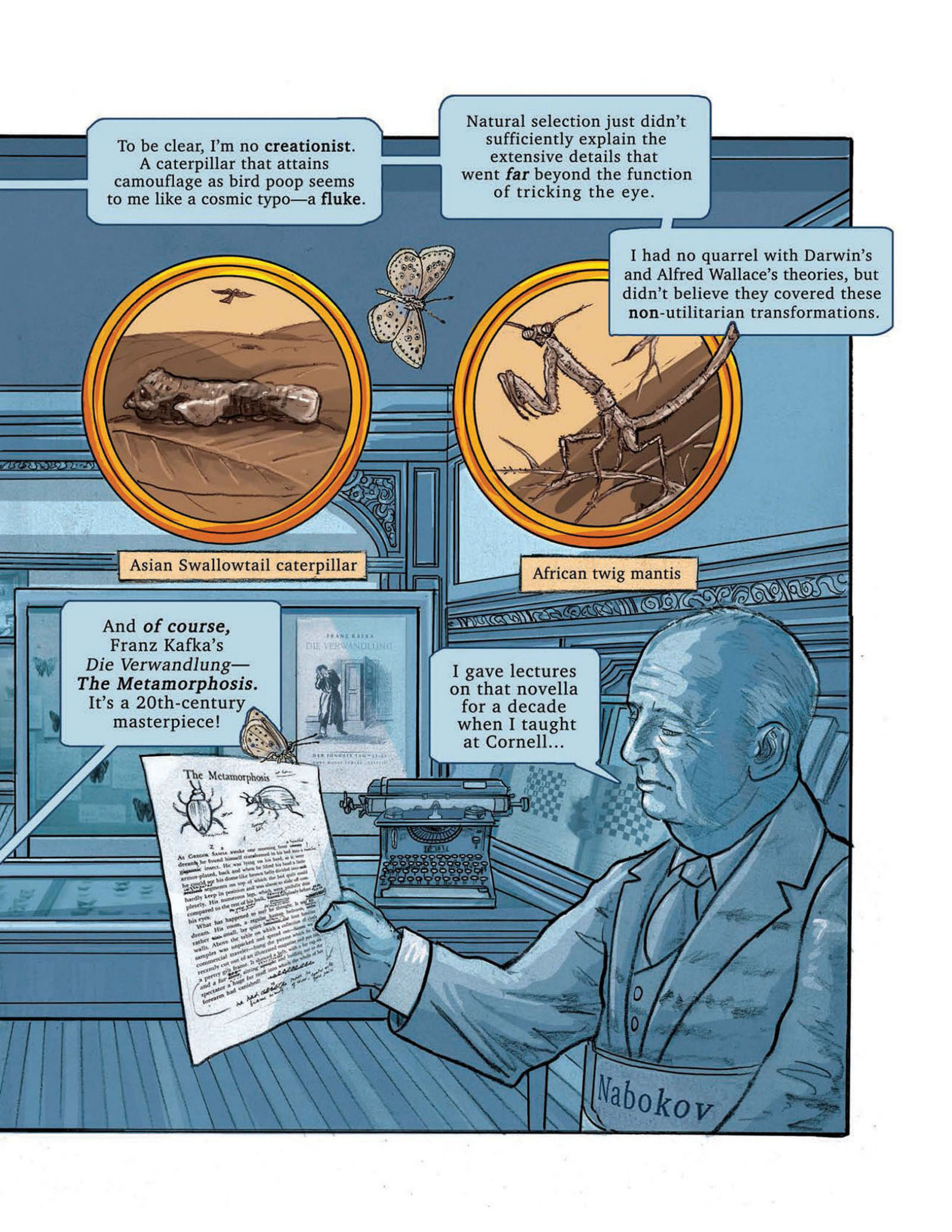
What are those?
Vladimir Nabokov
Drawings by a guy named Vladimir Nabokov.
It says he wrote a famous book called Lolita.

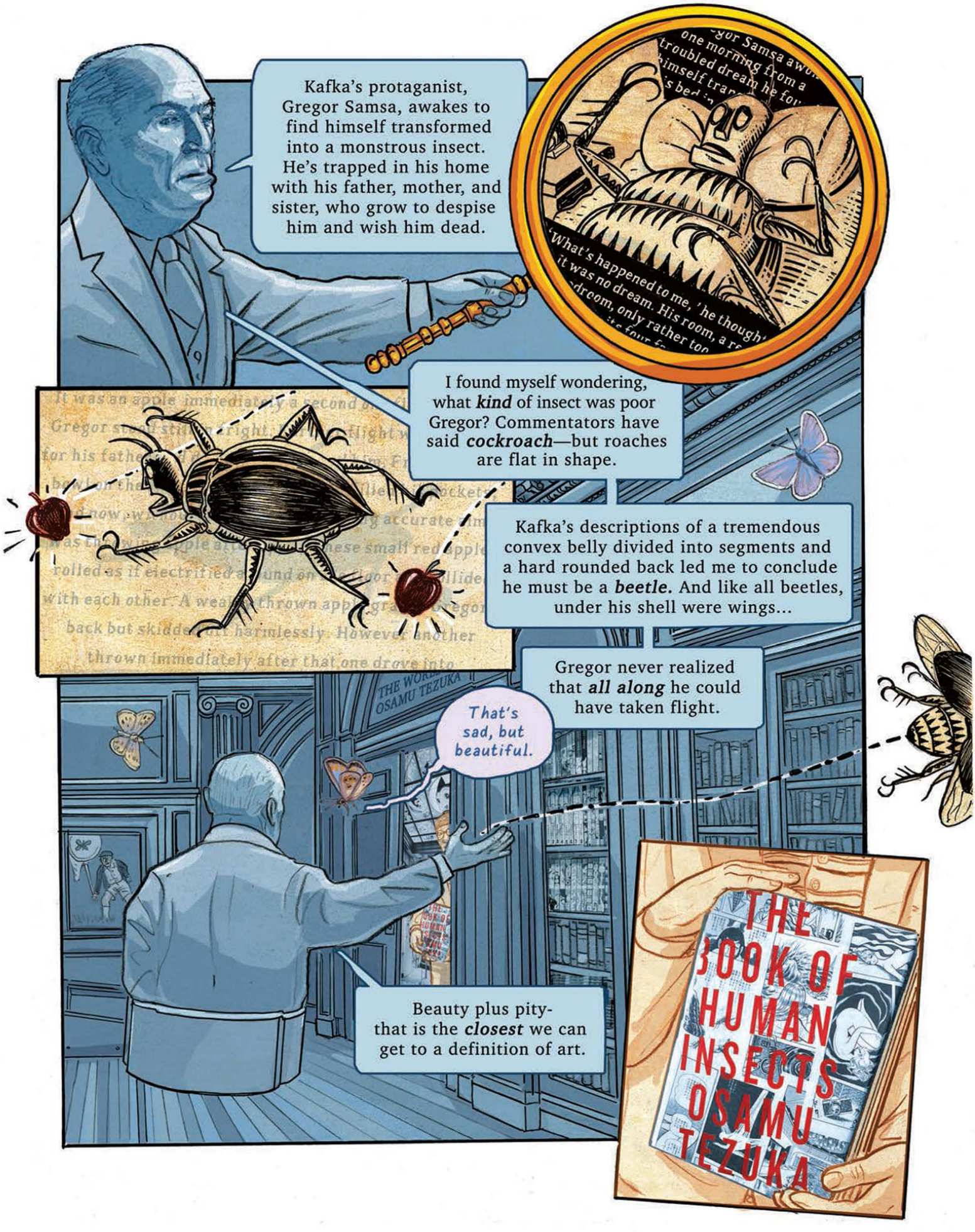

Had there been no Russian Revolution, I would have likely devoted myself entirely to the study of **butterflies**...
and never written any **novels** at all!
Vladimir Nabokov
1899-1977
I found in nature the kind of non-utilitarian delights I sought in art.
You can talk?!
Yes, but I only speak of ***memories.***
SPEAK, MEMORY
I spent a considerable amount of time focused on your species, the ***Polyommatus Blues***.
I postulated that your ancestors had come from Asia across the Bering Strait and over a period of ten million years had made their way to South America.
That's wild!
That's what all the ***professional*** entomologists told me at the time...
But you proved it—right?
No.
Vladimir Nabokov
1899-1977

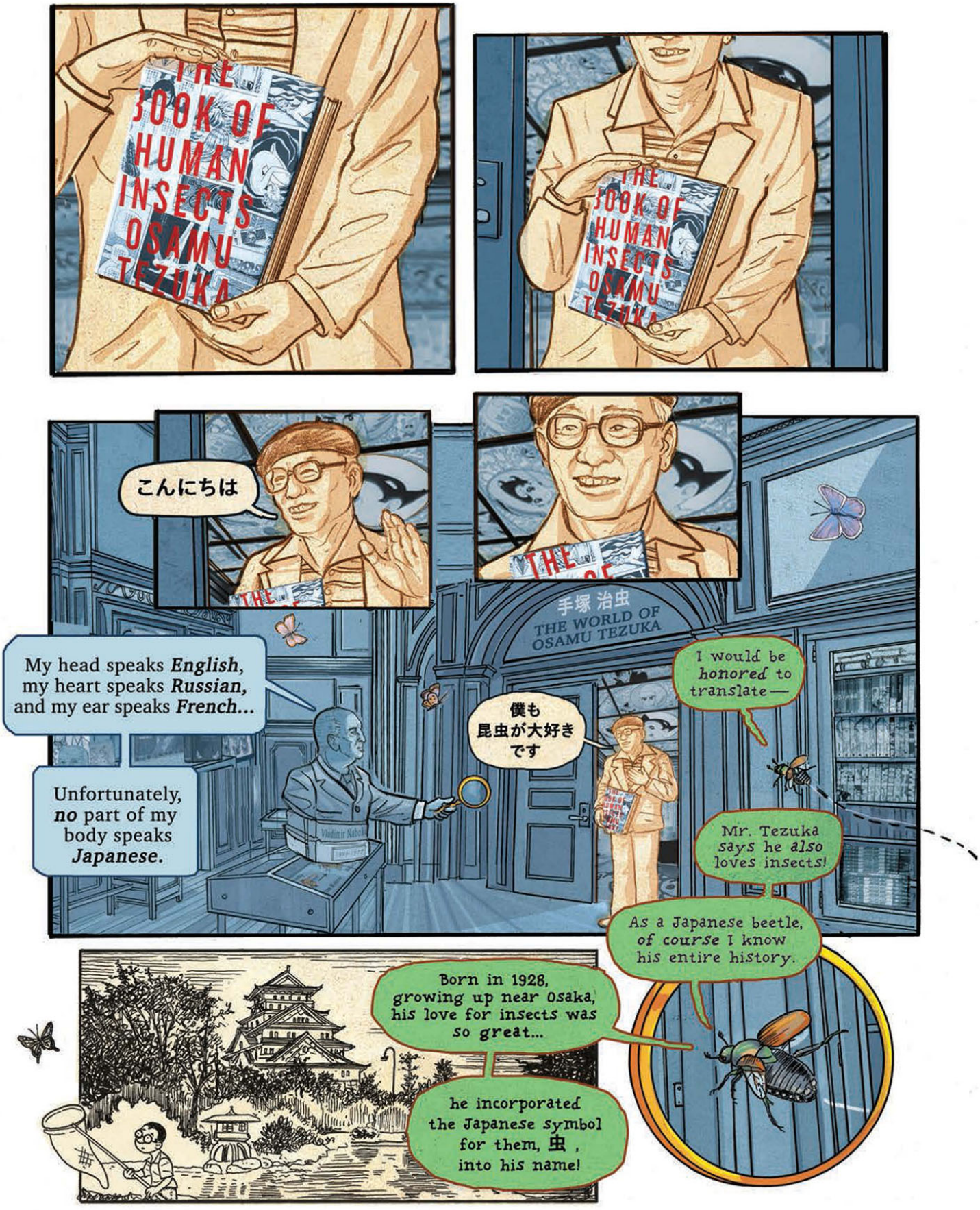

I couldn't prove it ***definitively*** with the science of my era, but I determined it to be true. Like a biologist in a Wellsian time machine flying through the Cenozoic, I was able to make these connections.
And posthumously, my conjecture was verified through DNA analysis!
How did you come up with your theory?
Inspiration is a matter of ***recognition***, of caressing the details, the divine details.
In high art and pure science, detail is ***everything.***
BERING STRAIT
SIBERIA
ALASKA
BERING SEA
PACIFIC OCEAN
VLADIMIR NABOKOV
UNDER GLASS
One must think with the imagination of a **poet** and the precision of a **scientist.**
Okay, but that doesn't answer my question.
"MAGIC TRIANGLES"
LOLITA
Hey— check this out!
I made drawings of the Blues' ***genitalia*** and by examining their elaborate sculpture, discovered a spatial and temporal roadmap linking species and the dispersal of their ancestors from the Old World to the New.
You figured it out from sketching our ***privates*** ??


Look, there's a couple of monarchs!
Actually, I'm a viceroy.
I'm the monarch.
She's just a mimic.
NABOKOV ON MIMICRY
Limenitis archippus
Danaus plexippus
VLADIMIR NABOKOV ADA A New Novel by the Author of LOLITA
NABOKOV
DR. FRITZ MÜLLER
Müllerian mimicry, named after German naturalist Fritz Müller (1821–1897) for his hypothosis on the phenomenon in which two or more species evolve to share a similar appearance. For example, two species of unpalatable butterflies appear similar to one another in different populations and over generations. This similarity signals predators to avoid attack.
Until 1991, the viceroy looking like the monarch was believed to be Batesian mimicry.
Though I had identified it as Müllerian mimicry decades earlier!
What's the difference?
The Atlantic Monthly
NABOKOV'S Butterflies
A Batesian mimic is harmless. A classic example is the hover fly. By adopting coloration of a bee or wasp, it deceives predators into thinking it can sting.
Vladimir Nabokov
1899-1977
Müllerian mimics, like the wasp and the bee, both have defenses. They share warning colors to deter predators from attacking.
Hover fly
Wasp
Honey Bee
Batesian Mimicry
Müllerian Mimicry
Common wisdom held that viceroys were tasty and so evolved to appear like monarchs, who are toxic to predators because they feed on the milkweed plant.
How did you determine it was Müllerian mimicry?
I sampled them...
CRUNCH
MUNCH
Both tasted vile.
?!

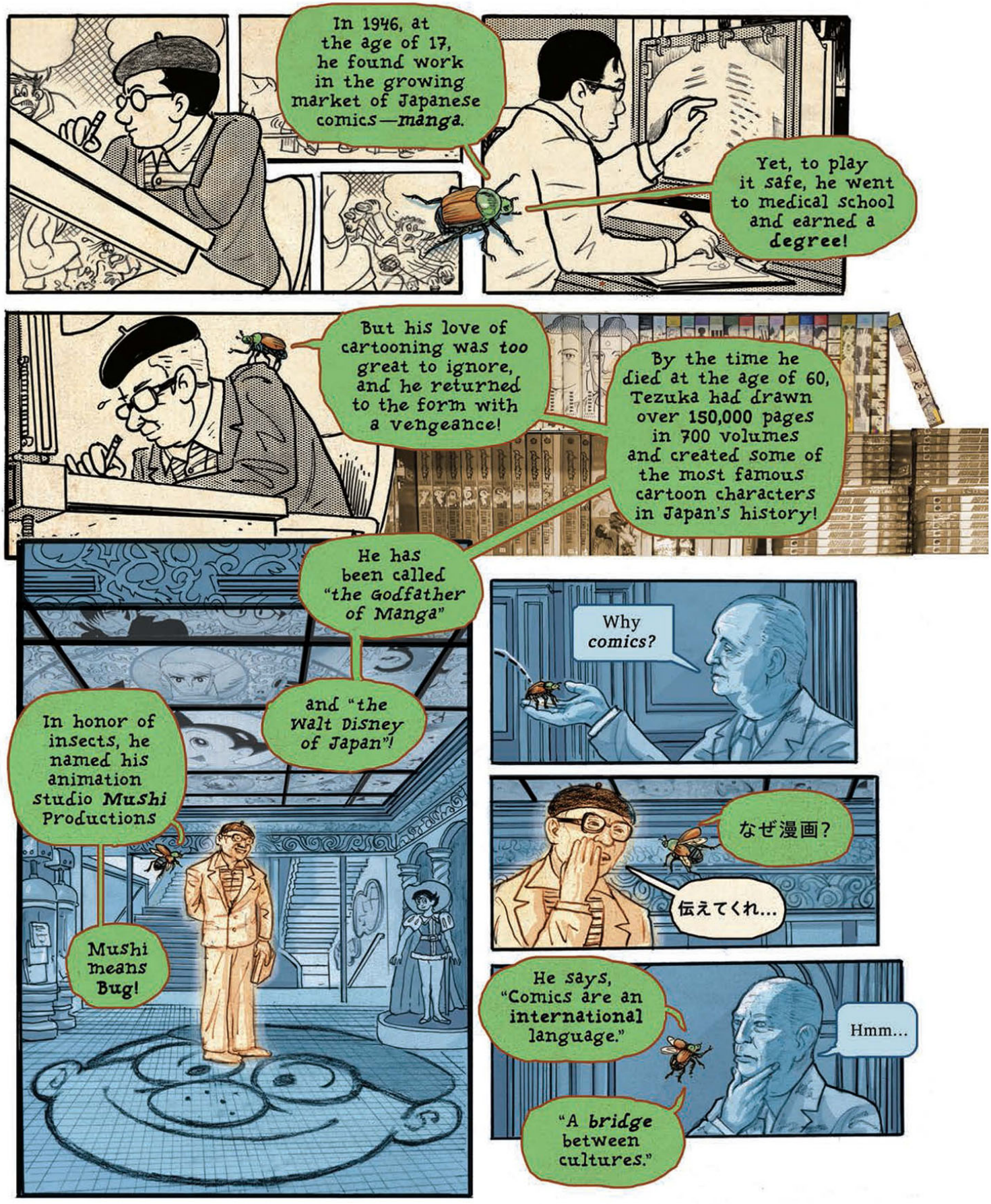

The mysteries of mimicry have always attracted me.
Though I've argued that the **teleology**—why mimicry occurs—is disputable.
I felt crypsis—when an organism gains invisibility masquerading as an inert object in its environment—could happen ***suddenly.***
Evolutionary gradualism failed to account for the possibility of spontaneous change and ***coincidence.***
Dead leaf butterfly
Pine hawk-moth
However, I did find much to complain about many of my fellow writers...
Such as?
Ezra Pound-***Fraud***
Dostoevsky—***Ghastly***
Conrad—***Juvenile***
Camus—***Awful***
D. H. Lawrence—***Execrable***
Hemingway, with his ***bells, balls, and bulls...***
Wow—did you like anybody?
Shakespeare, Borges, Beckett, Salinger, Lewis Carroll-Jane Austen is marvelous, Joyce's *Ulysses,* ***brilliant...***
Véra Yevseyevna Nabokova (1902-1991) wife, editor, and translator
Véra
Vladimir Nabokov
1899-1977

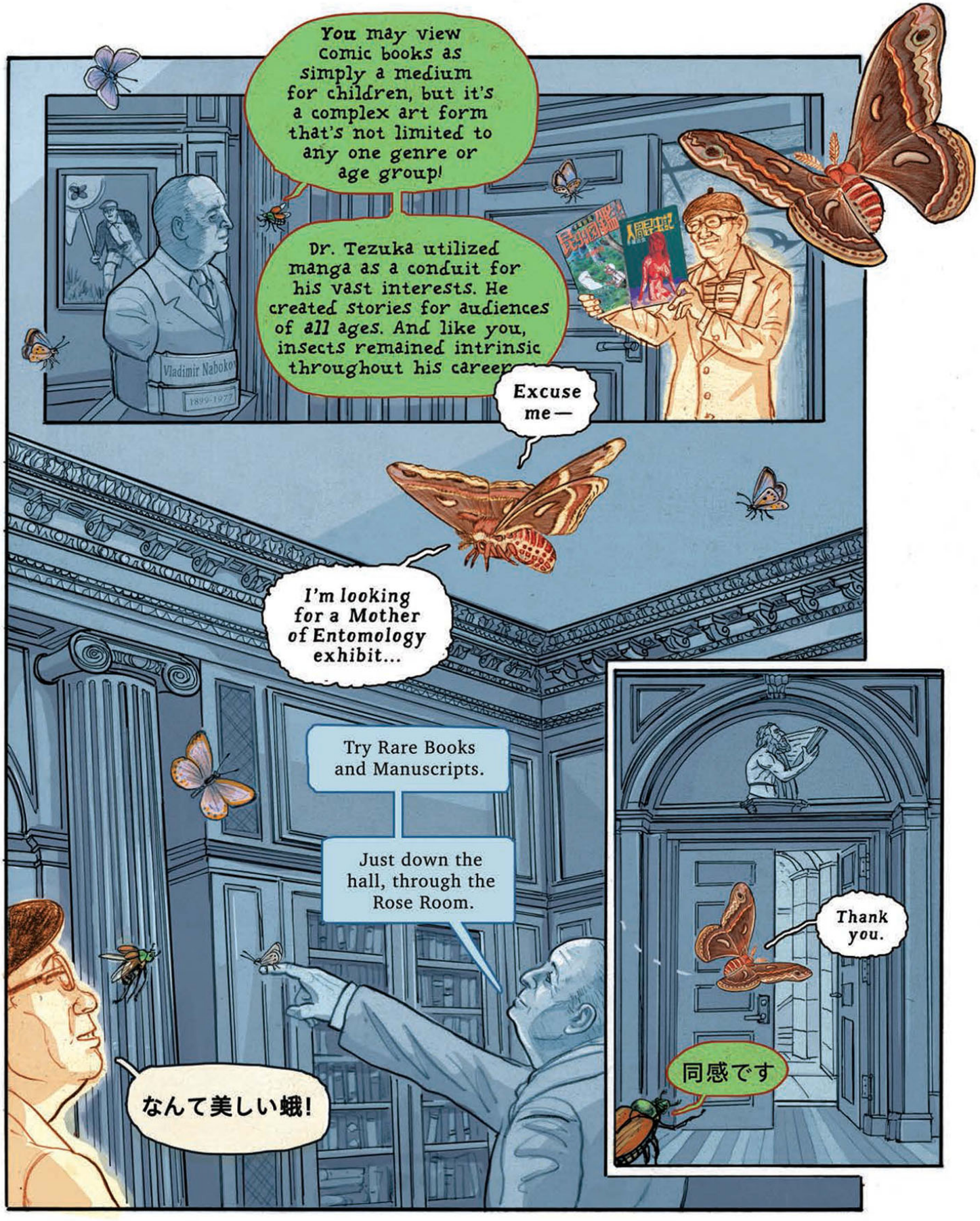

To be clear, I'm no **creationist**. A caterpillar that attains camouflage as bird poop seems to me like a cosmic typo—a **fluke**.
Natural selection just didn't sufficiently explain the extensive details that went ***far*** beyond the function of tricking the eye.
I had no quarrel with Darwin's and Alfred Wallace's theories, but didn't believe they covered these **non**-utilitarian transformations.
Asian Swallowtail caterpillar
African twig mantis
And ***of course,*** Franz Kafka's *Die Verwandlung*— ***The Metamorphosis.*** It's a 20th-century masterpiece!
I gave lectures on that novella for a decade when I taught at Cornell...
FRANZ KAFKA
DIE VERWANDLUNG
The Metamorphosis
Nabokov

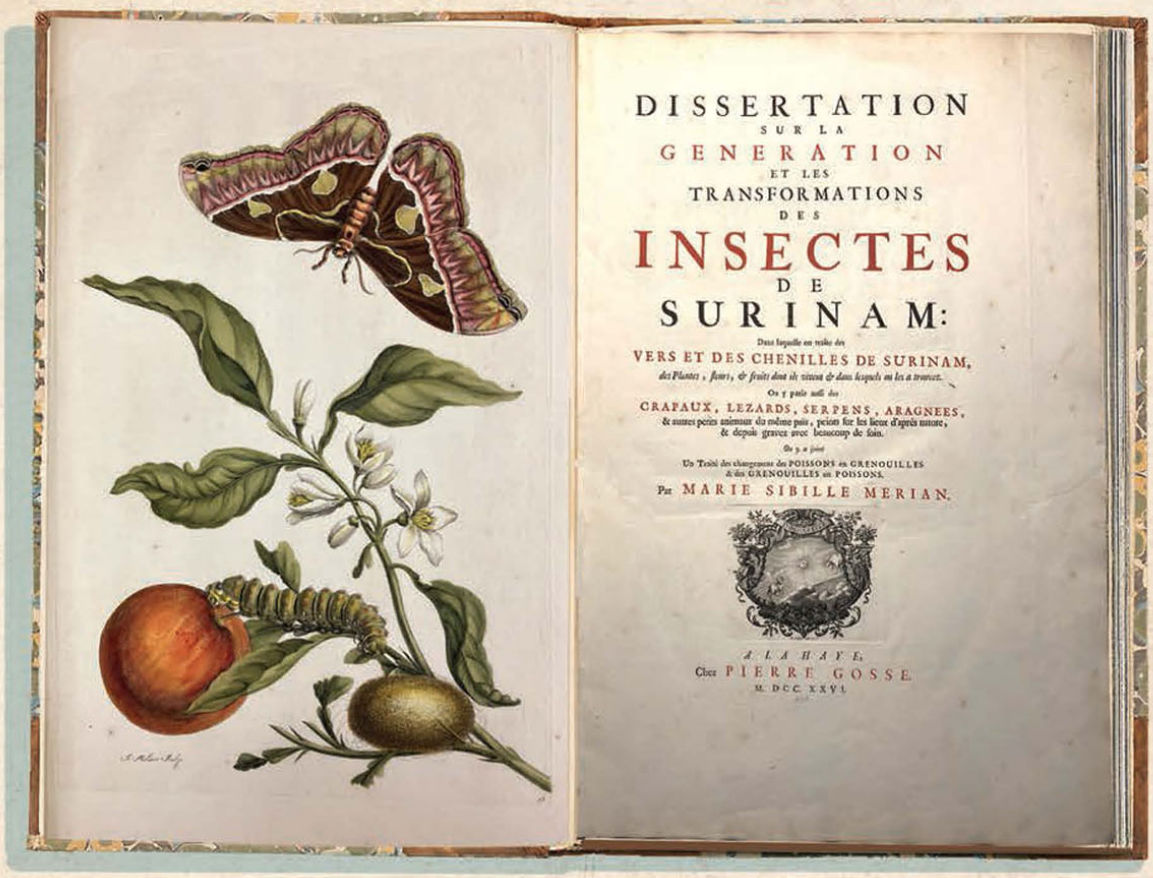

Kafka's protaganist, Gregor Samsa, awakes to find himself transformed into a monstrous insect. He's trapped in his home with his father, mother, and sister, who grow to despise him and wish him dead.
I found myself wondering, what *kind* of insect was poor Gregor? Commentators have said ***cockroach***—but roaches are flat in shape.
Kafka's descriptions of a tremendous convex belly divided into segments and a hard rounded back led me to conclude he must be a ***beetle.*** And like all beetles, under his shell were wings...
Gregor never realized that ***all along*** he could have taken flight.
That's sad, but beautiful.
Beauty plus pity- that is the ***closest*** we can get to a definition of art.
THE BOOK OF HUMAN INSECTS
OSAMU TEZUKA


THE BOOK OF HUMAN INSECTS OSAMU TEZUKA
こんにちは
手塚 治虫
THE WORLD OF OSAMU TEZUKA
My head speaks *English*, my heart speaks *Russian*, and my ear speaks *French*...
Unfortunately, *no* part of my body speaks *Japanese*.
僕も昆虫が大好きです
I would be *honored* to translate—
Mr. Tezuka says he *also* loves insects!
As a Japanese beetle, *of course* I know his entire history.
Born in 1928, growing up near Osaka, his love for insects was so great...
he incorporated the Japanese symbol for them, 虫, into his name!

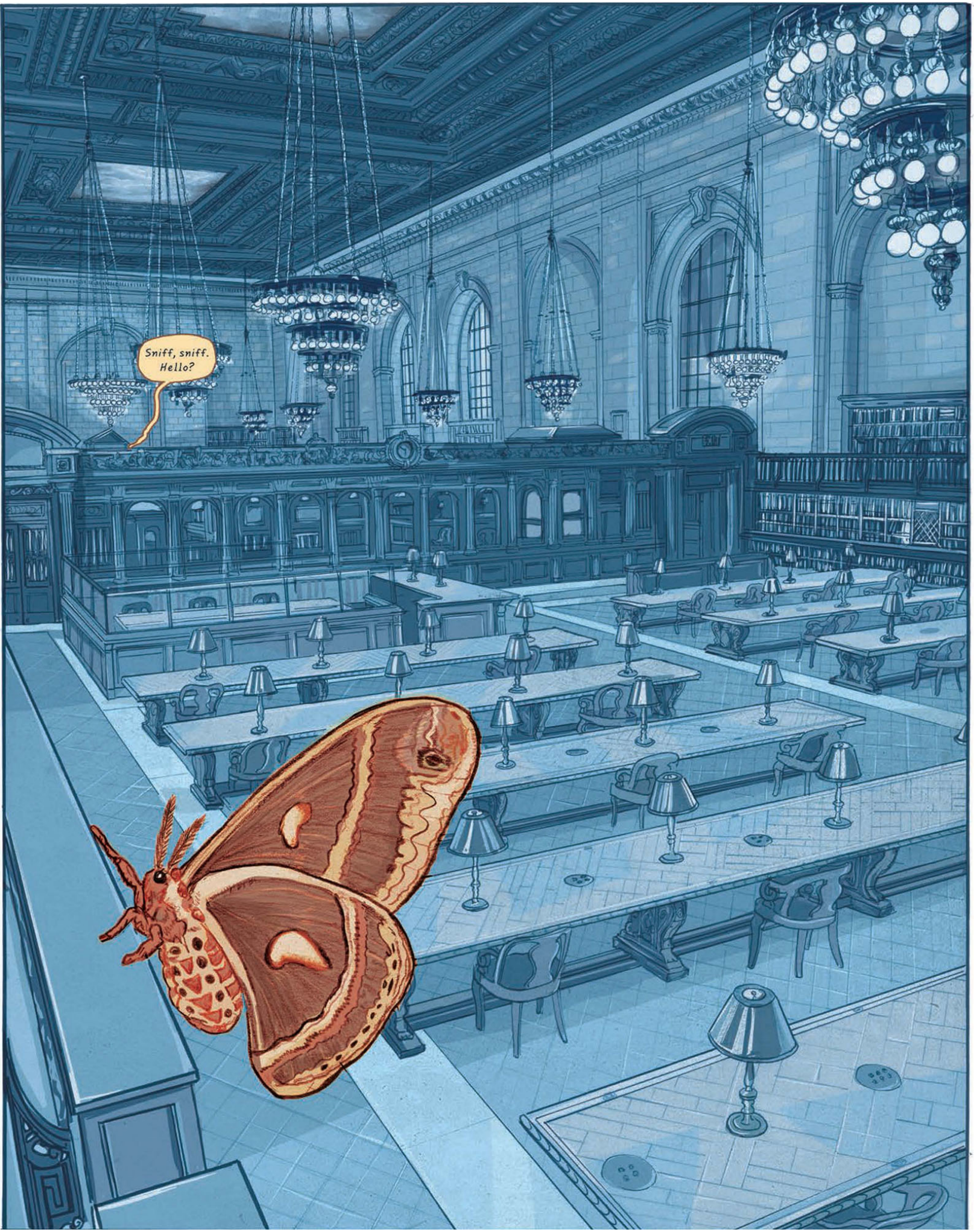
His obsession with entomology drove him...
to collect and study all of us intently.
He cataloged each type with copious notes and *remarkably* detailed drawings.
As a teenager Tezuka was exposed to everything from Walt Disney, to Charlie Chaplin, to American comic books...
He swallowed *all* of it whole and began creating his *own* comics.
ALL AMERICAN COMICS
HAHA COMICS
HE DONE HER WRONG
WALT DISNEY'S MICKEY MOUSE
America's BEST COMICS
ALL WINNERS

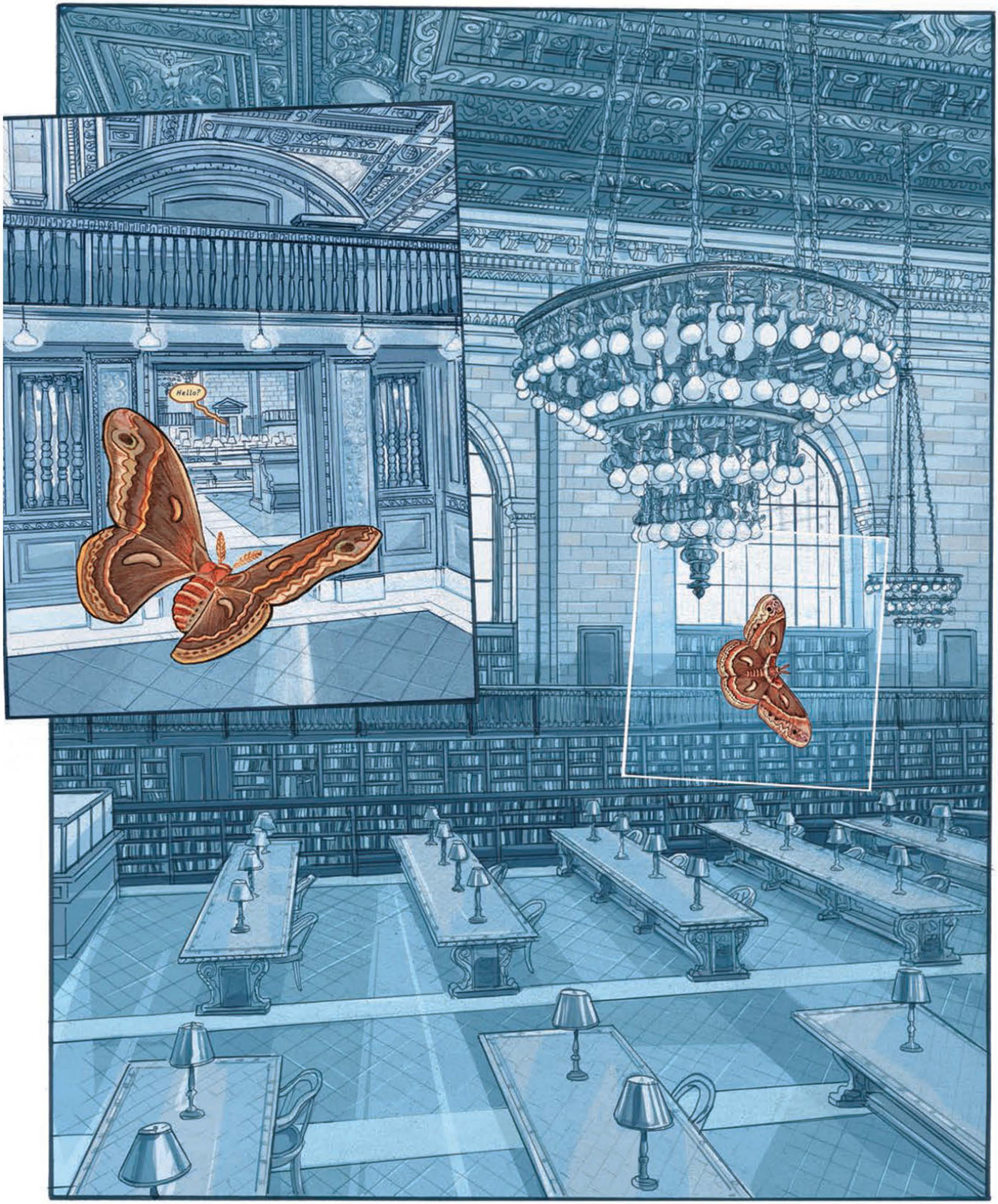

In 1946, at the age of 17, he found work in the growing market of Japanese comics—*manga*.
Yet, to play it safe, he went to medical school and earned a **degree**!
But his love of cartooning was too great to ignore, and he returned to the form with a vengeance!
By the time he died at the age of 60, Tezuka had drawn over 150,000 pages in 700 volumes and created some of the most famous cartoon characters in Japan's history!
He has been called "the Godfather of Manga"
and "the Walt Disney of Japan"!
In honor of insects, he named his animation studio **Mushi** Productions
Mushi means Bug!
Why *comics*?
なぜ漫画？
伝えてくれ…
He says, "Comics are an **international** language."
"A *bridge* between cultures."
Hmm…

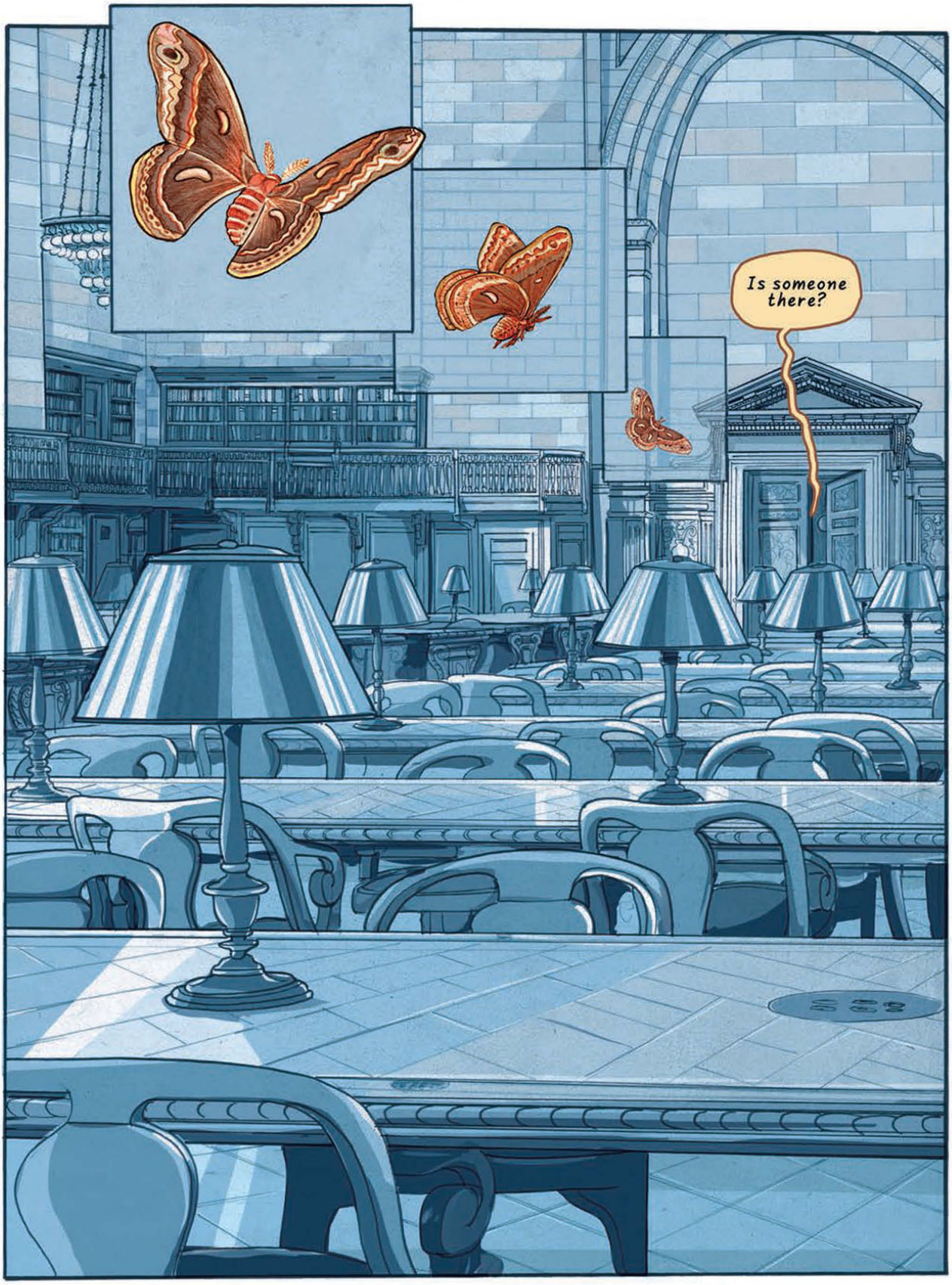

You may view comic books as simply a medium for children, but it's a complex art form that's not limited to any one genre or age group!
Dr. Tezuka utilized manga as a conduit for his vast interests. He created stories for audiences of all ages. And like you, insects remained intrinsic throughout his career.
Vladimir Nabokov
1899-1977
Excuse me—
I'm looking for a Mother of Entomology exhibit...
Try Rare Books and Manuscripts.
Just down the hall, through the Rose Room.
なんて美しい蛾!
Thank you.
同感です



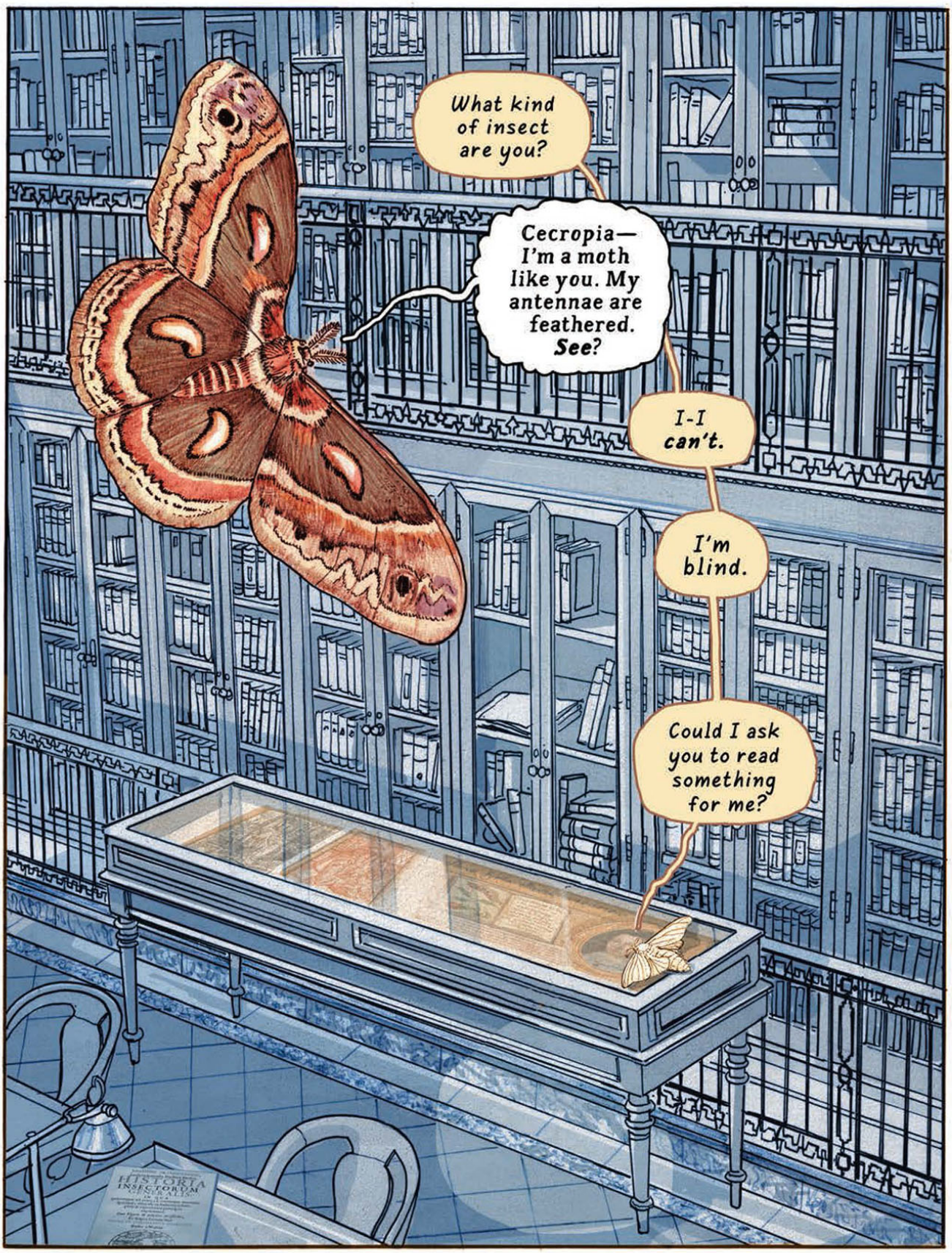
Maria Sibylla Merian
(1647-1717)
Transformation of the Insects of Suriname
Published in Amsterdam in 1705,
it included 60 of Merian's
hand-colored engravings.


Sniff, sniff.
Hello?

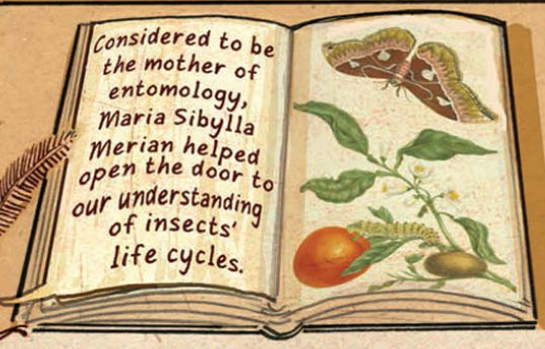

Hello?


Is someone there?

Is this Rare Books?
Yes...


What kind of insect are you?
Cecropia— I'm a moth like you. My antennae are feathered. See?
I-I can't.
I'm blind.
Could I ask you to read something for me?
HISTORIA INSECTORUM

Maria Sibylla Merian 1647–1717

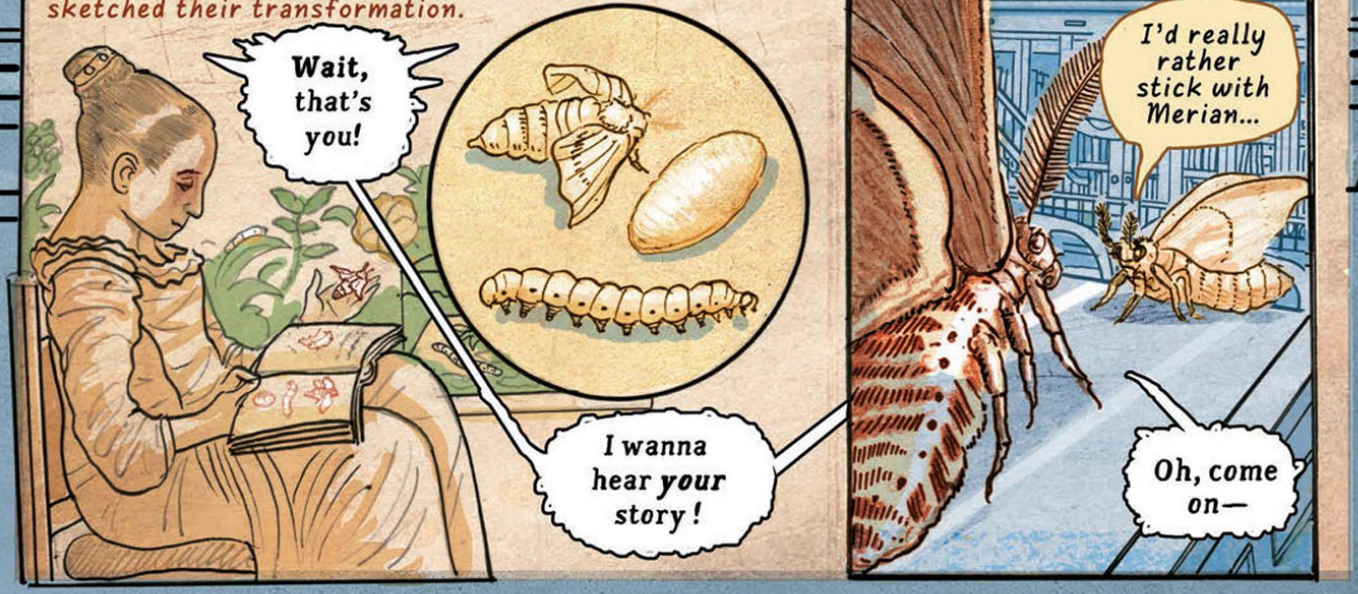

Considered to be the mother of entomology, Maria Sibylla Merian helped open the door to our understanding of insects' life cycles.

Until Merian's time, Aristotelian theory held that insects were spontaneously generated from organic matter like mud or meat and every insect stage was a separate creature. This was debunked, thanks in large part to Merian's explorations and her groundbreaking illustrations.

Born in Frankfurt in 1647.

Merian was surrounded by art and tutored by her stepfather, Jacob Marrel, an accomplished floral painter. He encouraged young Maria to pursue her passions.

At the age of thirteen, she began raising silk moths and sketched their transformation.



Sigh Well, okay...

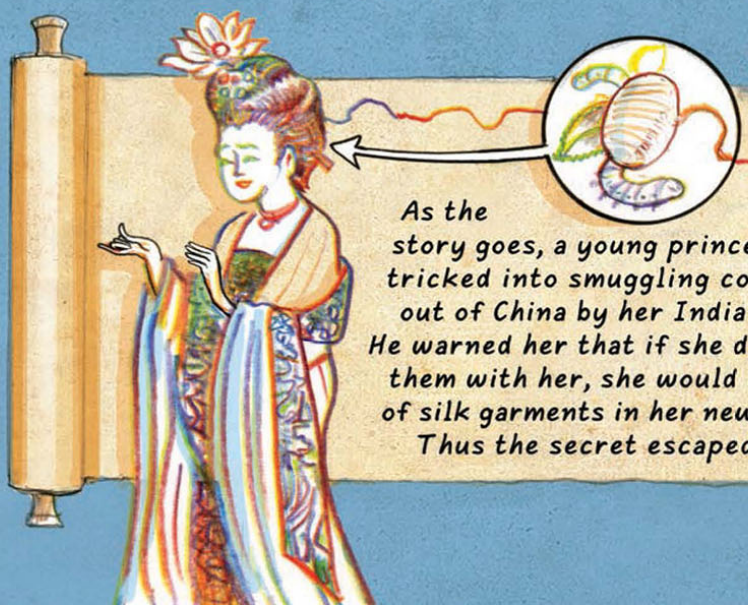
The legend has it, we were **discovered** in 2640 B.C.E. by a Chinese Empress named Leizu. She was sitting under a mulberry tree when...

As she attempted to fish the cocoon out of her tea, a strand of fiber came loose.

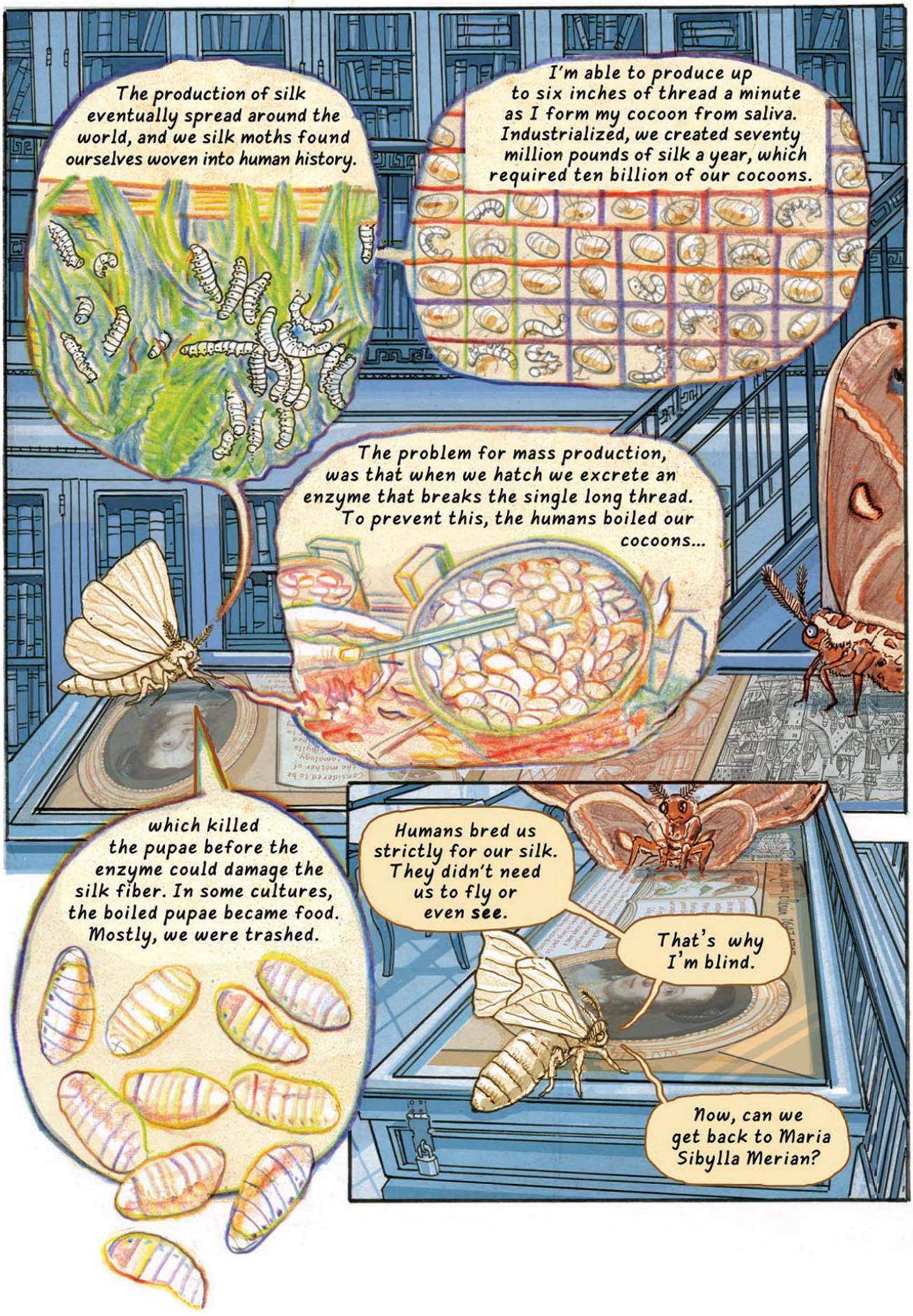
When it wrapped around her finger, the silk strand unraveled...

and unraveled until it was a mile long! The magnificent silk fabric produced from the thread quickly became more precious than gold or jade, enriching China's dynasties.

They managed to guard the secret of its production for the next 2000 years.



As the story goes, a young princess was tricked into smuggling cocoons out of China by her Indian fiancé. He warned her that if she didn't bring them with her, she would be bereft of silk garments in her new kingdom. Thus the secret escaped China!


The production of silk eventually spread around the world, and we silk moths found ourselves woven into human history.
I'm able to produce up to six inches of thread a minute as I form my cocoon from saliva. Industrialized, we created seventy million pounds of silk a year, which required ten billion of our cocoons.
The problem for mass production, was that when we hatch we excrete an enzyme that breaks the single long thread. To prevent this, the humans boiled our cocoons...
which killed the pupae before the enzyme could damage the silk fiber. In some cultures, the boiled pupae became food. Mostly, we were trashed.
Humans bred us strictly for our silk. They didn't need us to fly or even see.
That's why I'm blind.
Now, can we get back to Maria Sibylla Merian?

Oh, sorry.
Let's see...um, she got married, had two kids, joined some kind of religious group called the Labadists, got divorced, moved to Amsterdam...

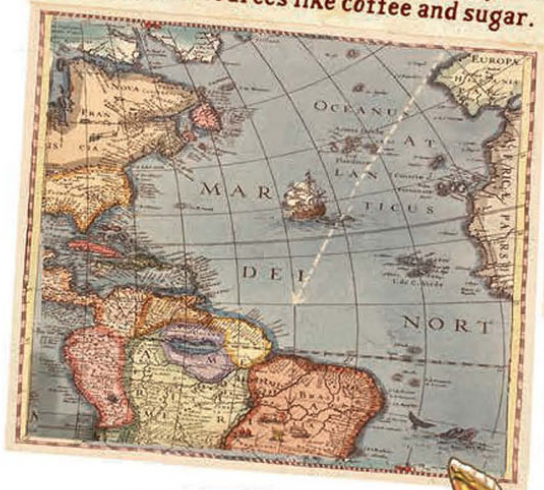
Ah—here's where it gets interesting...

For years Merian had heard about a Dutch colony called Suriname.

Visitors there returned with an astonishing variety of insects and plants.

So, in 1699, at age 52, Merian made a bold move. By selling her paintings she raised enough money for the two-month transatlantic journey to South America. Accompanied by her daughter, Dorothea, Merian was the first female naturalist to ever explore Suriname.

In 1667, Suriname had been traded with the English for a swampy island called...**Manhattan!** The Dutch thought they'd gotten the better end of the deal, obtaining a country rich in natural resources like coffee and sugar.

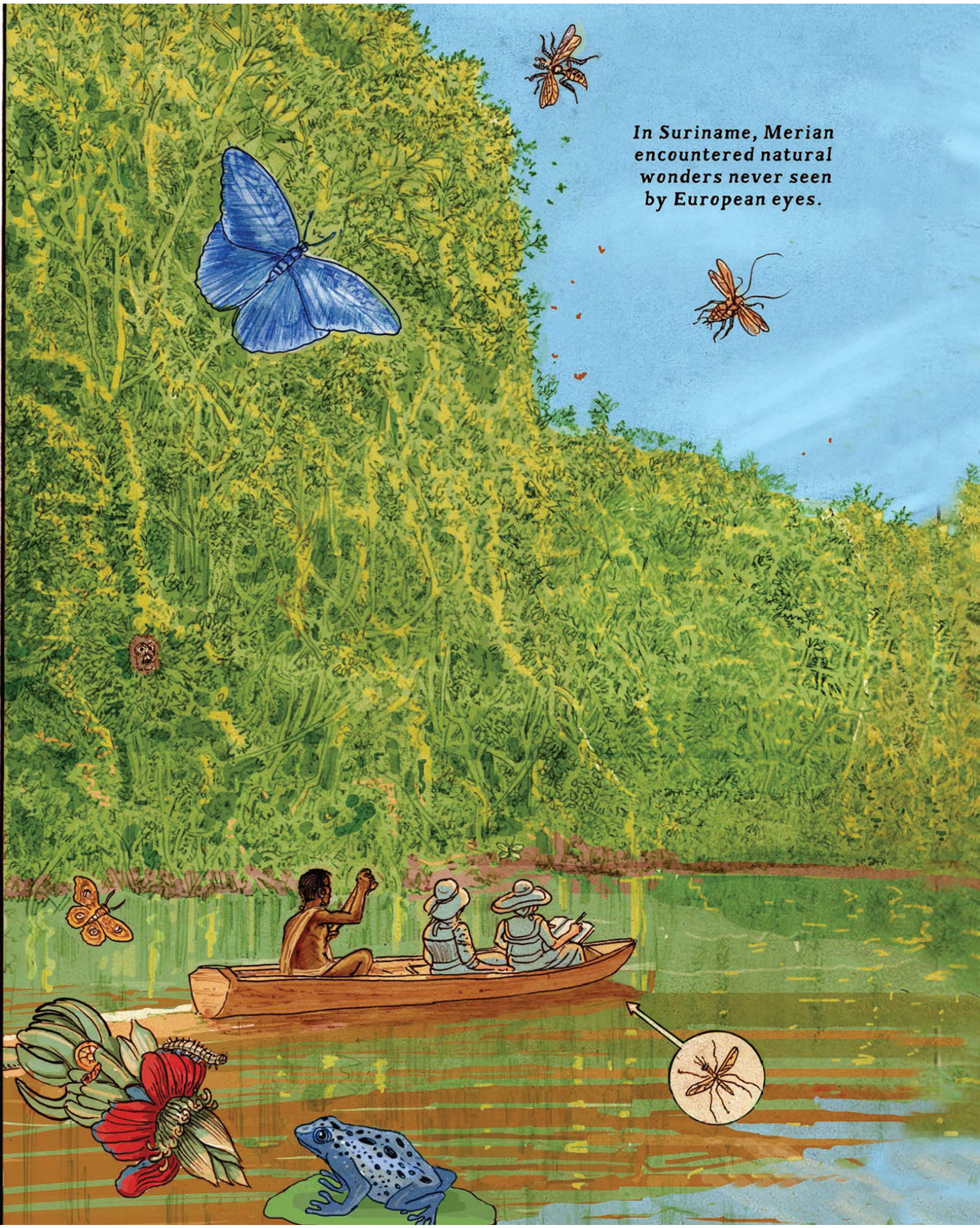


The Dutch intended to extract every pound of these riches. To do so, they enslaved and brutalized the Indigenous population as well as thousands of people kidnapped from Africa.

Merian, however, had come to Suriname for its wealth of nature.

Relying on the help of local guides, she was able to leave the beaten path...

and delve into the hidden world beyond.


In Suriname, Merian encountered natural wonders never seen by European eyes.

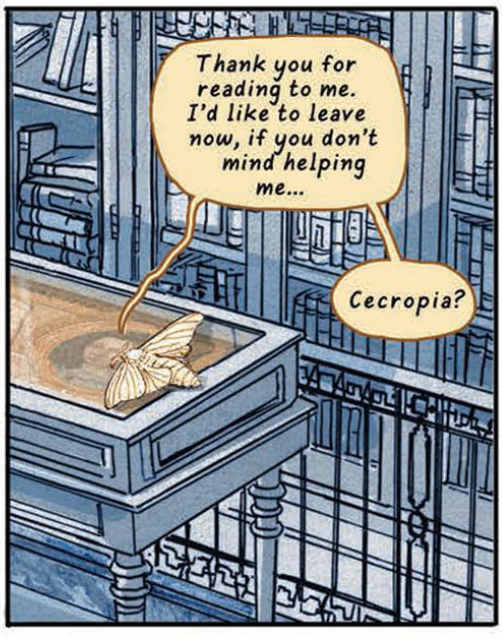
She captured these marvels in her beautiful, meticulous drawings...
Maria Sibylla Merian

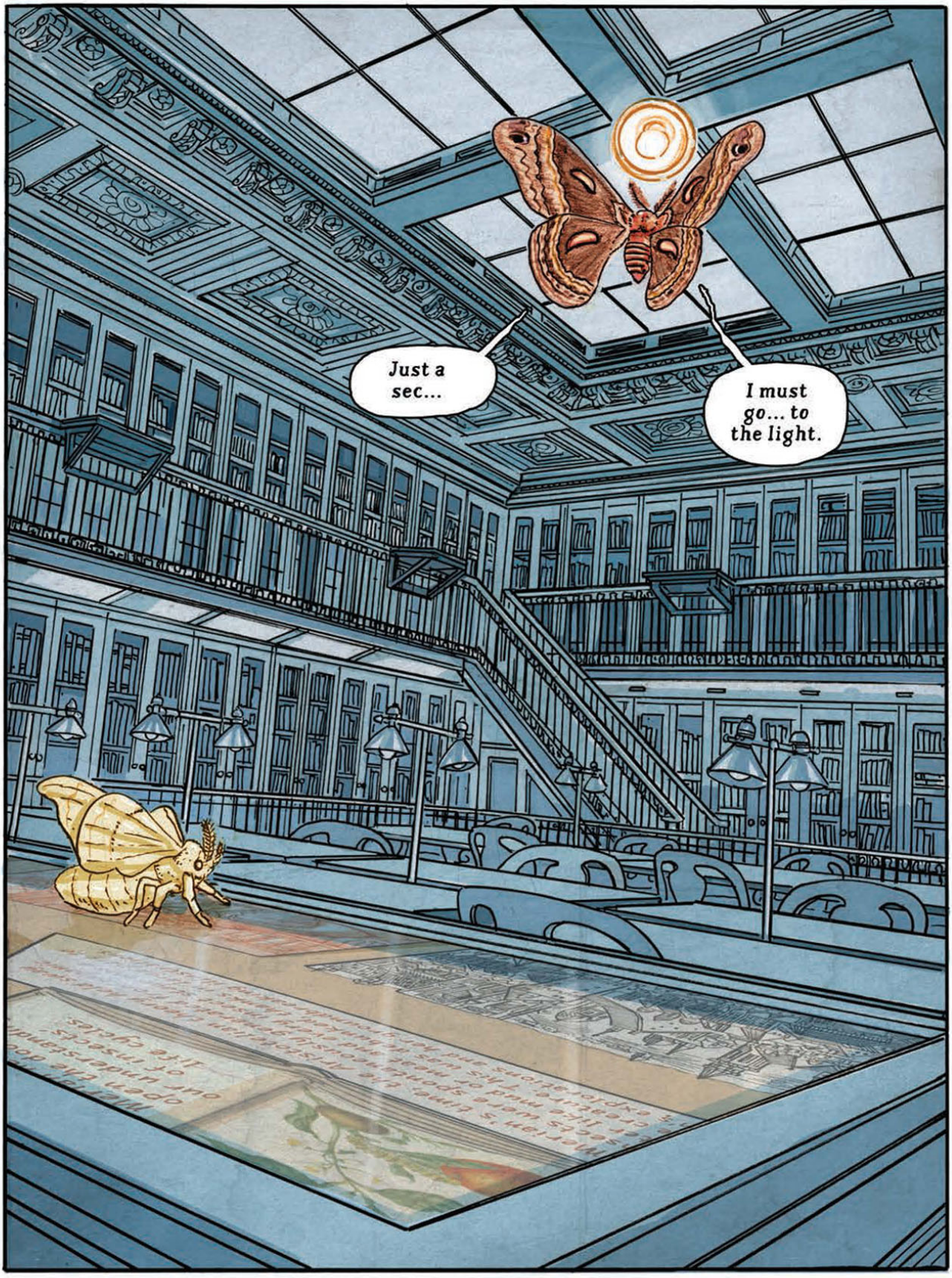
Merian's discoveries and the connections she made pairing insects to their chosen flora became foundational insights for generations of entomologists.

"The Indians...use the(Peacock) seeds to abort their children, so that they will not become slaves like themselves. The black slaves from Guinea and Angola have demanded to be well treated, threatening to refuse to have children. In fact, they sometimes take their own lives because they are treated so badly, and because they believe they will be born again, free and living in their own land."
—From Merian's journal
In addition to lighting her path, Merian's guides shared the rain-forest's darker secrets...
Merian intended to stay in Suriname for five years, but her time was cut short when she contracted a debilitating case of malaria. After two years of exploration, she returned to Amsterdam.

In 1705, she published the stunning images she'd begun in South America, a book of sixty hand-colored etchings titled ***Transformation of the Insects of Suriname.*** She died in 1717, working into her final year.

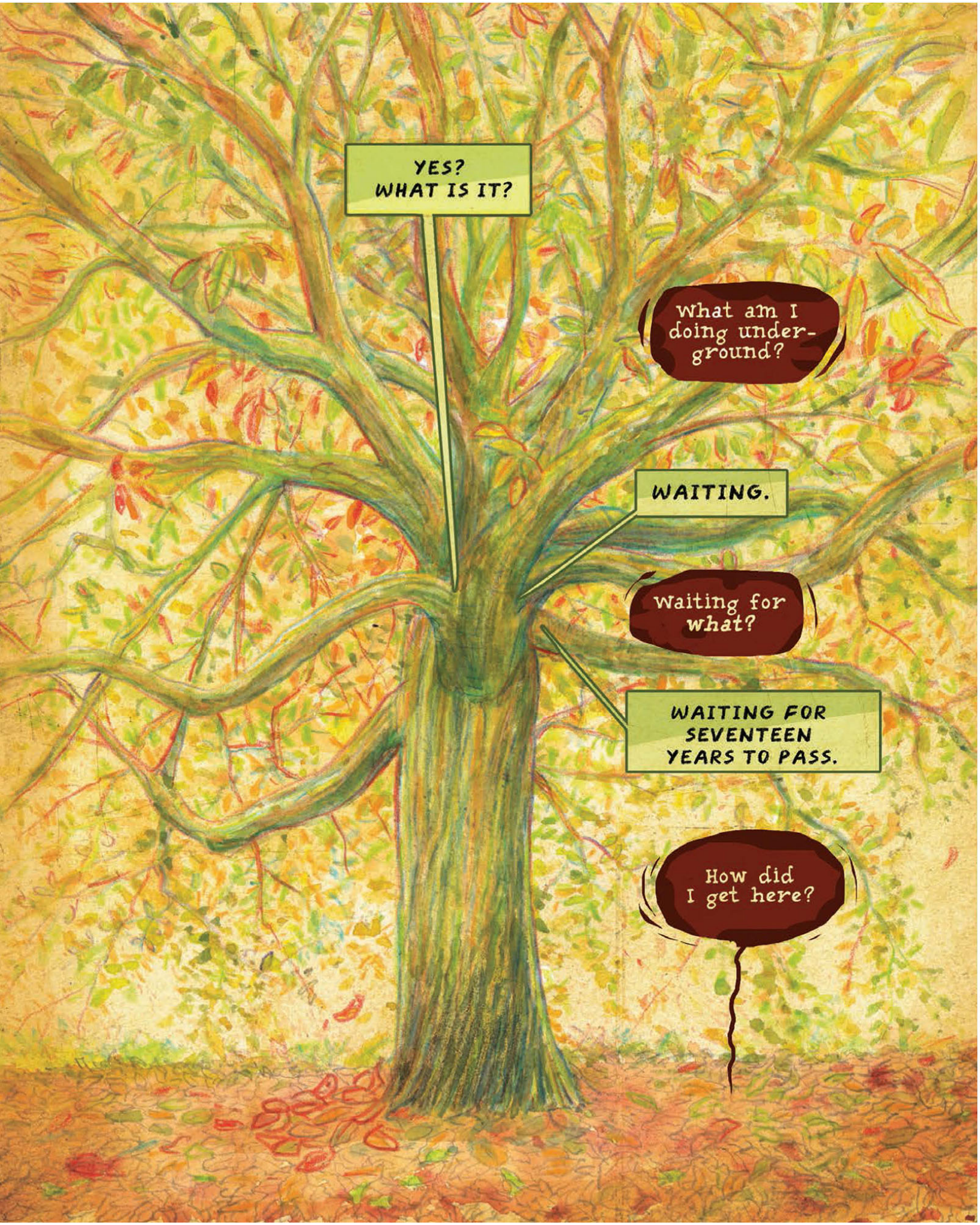
The importance of her contributions can't be overstated. Surmounting social norms, she produced critical insight into the natural world a century and a half before Charles Darwin.

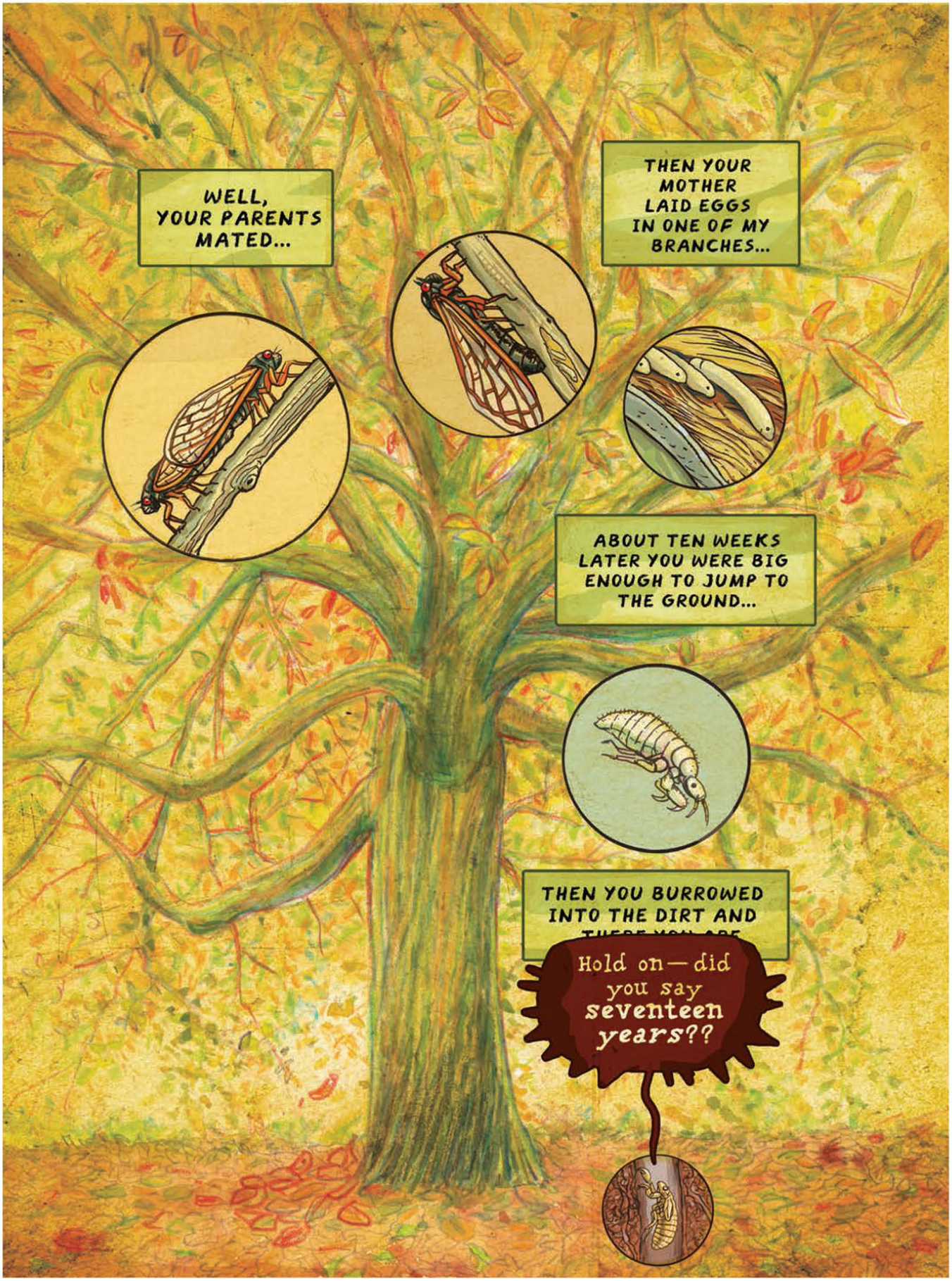


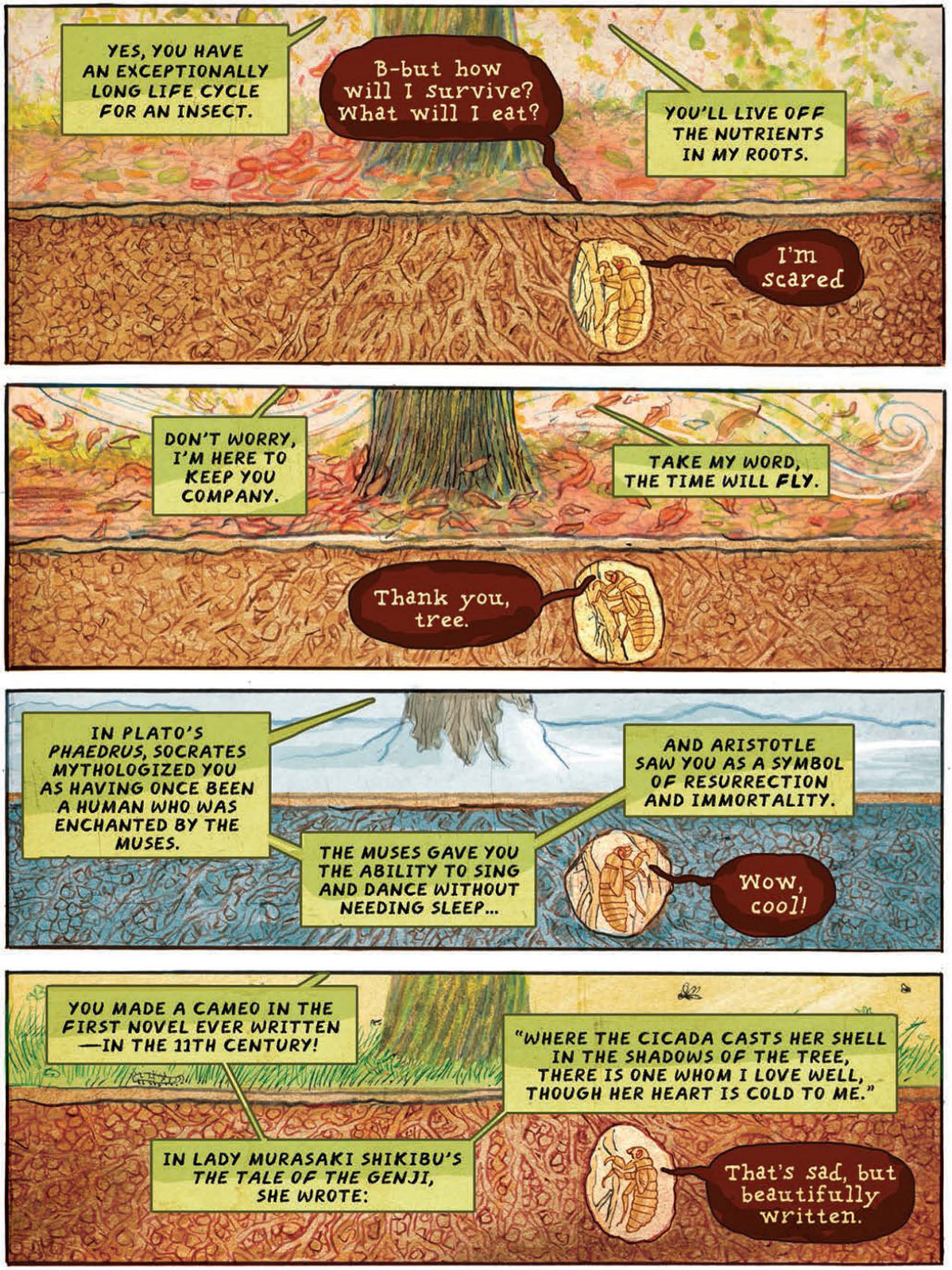

Just a sec...
I must go... to the light.

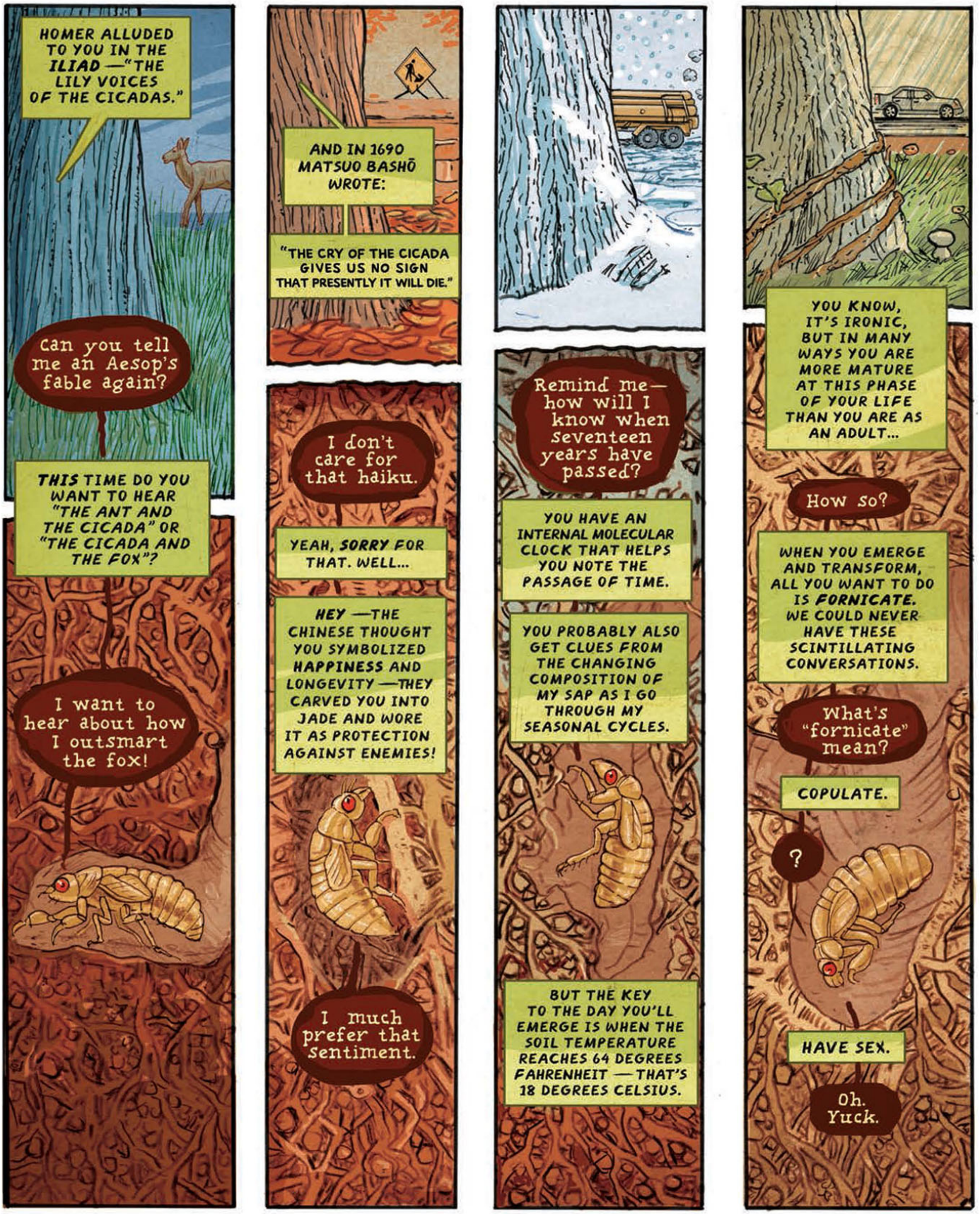
A Crying Cicada on an Autumn Willow
Shen Zhou
(1427-1509)
China, Ming Dynasty

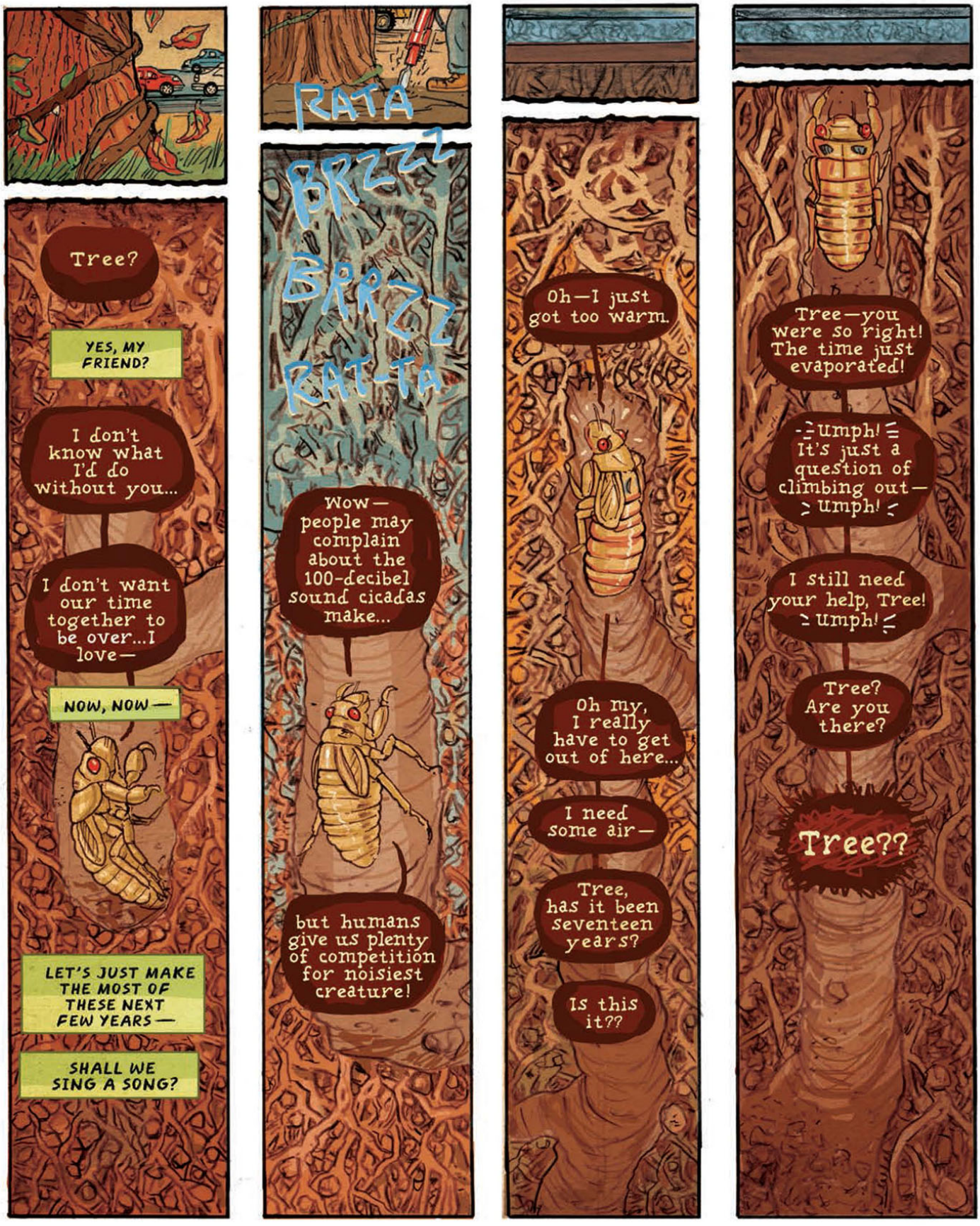
Tree?


YES? WHAT IS IT?
What am I doing under-ground?
WAITING.
Waiting for what?
WAITING FOR SEVENTEEN YEARS TO PASS.
How did I get here?


WELL, YOUR PARENTS MATED...
THEN YOUR MOTHER LAID EGGS IN ONE OF MY BRANCHES...
ABOUT TEN WEEKS LATER YOU WERE BIG ENOUGH TO JUMP TO THE GROUND...
THEN YOU BURROWED INTO THE DIRT AND
Hold on—did you say seventeen years??


YES, YOU HAVE AN EXCEPTIONALLY LONG LIFE CYCLE FOR AN INSECT.
B-but how will I survive? What will I eat?
YOU'LL LIVE OFF THE NUTRIENTS IN MY ROOTS.
I'm scared
DON'T WORRY, I'M HERE TO KEEP YOU COMPANY.
TAKE MY WORD, THE TIME WILL FLY.
Thank you, tree.
IN PLATO'S PHAEDRUS, SOCRATES MYTHOLOGIZED YOU AS HAVING ONCE BEEN A HUMAN WHO WAS ENCHANTED BY THE MUSES.
AND ARISTOTLE SAW YOU AS A SYMBOL OF RESURRECTION AND IMMORTALITY.
THE MUSES GAVE YOU THE ABILITY TO SING AND DANCE WITHOUT NEEDING SLEEP...
Wow, cool!
YOU MADE A CAMEO IN THE FIRST NOVEL EVER WRITTEN —IN THE 11TH CENTURY!
"WHERE THE CICADA CASTS HER SHELL IN THE SHADOWS OF THE TREE, THERE IS ONE WHOM I LOVE WELL, THOUGH HER HEART IS COLD TO ME."
IN LADY MURASAKI SHIKIBU'S THE TALE OF THE GENJI, SHE WROTE:
That's sad, but beautifully written.

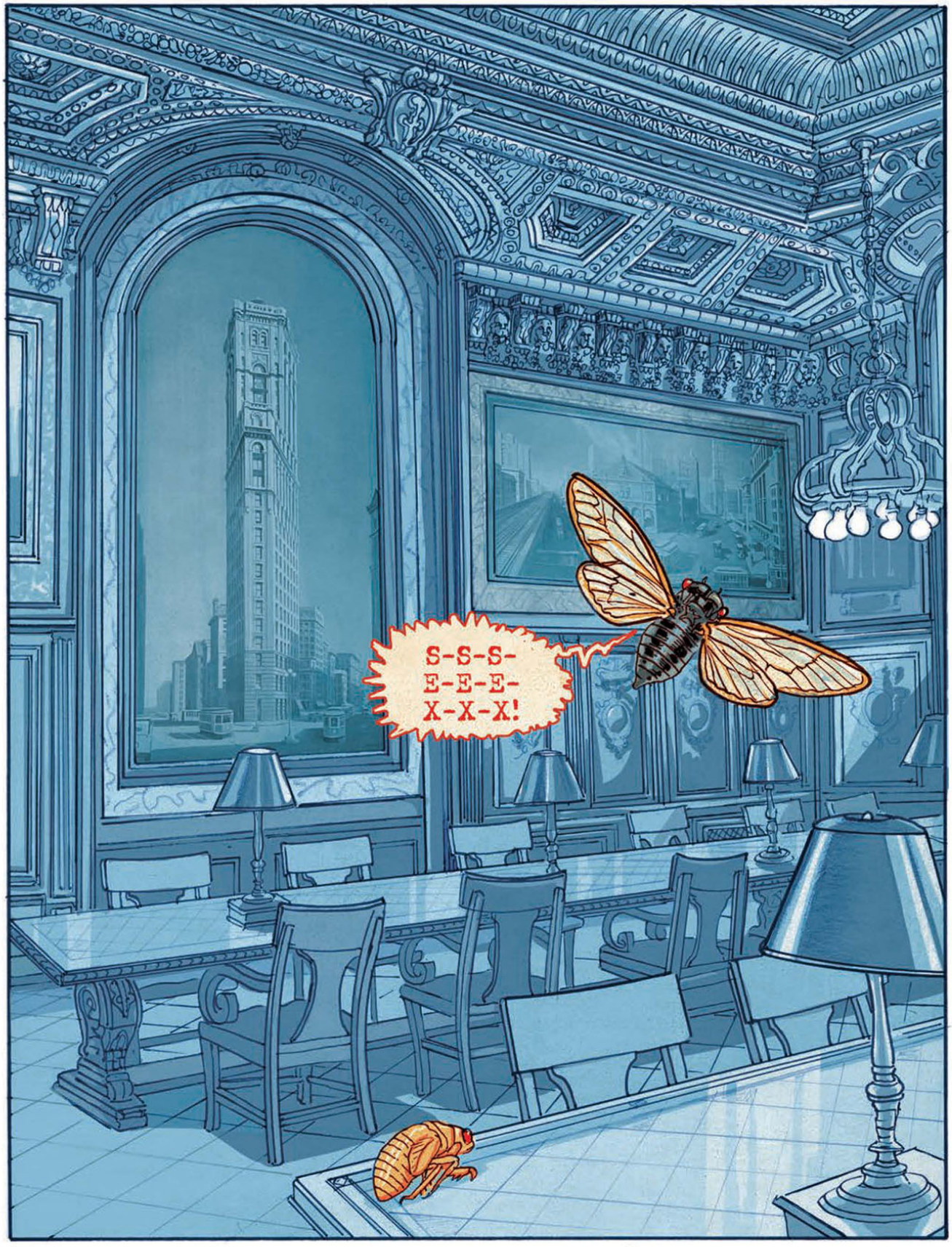

HOMER ALLUDED TO YOU IN THE ILIAD —"THE LILY VOICES OF THE CICADAS."
Can you tell me an Aesop's fable again?
THIS TIME DO YOU WANT TO HEAR "THE ANT AND THE CICADA" OR "THE CICADA AND THE FOX"?
I want to hear about how I outsmart the fox!
AND IN 1690 MATSUO BASHŌ WROTE:
"THE CRY OF THE CICADA GIVES US NO SIGN THAT PRESENTLY IT WILL DIE."
I don't care for that haiku.
YEAH, SORRY FOR THAT. WELL...
HEY —THE CHINESE THOUGHT YOU SYMBOLIZED HAPPINESS AND LONGEVITY —THEY CARVED YOU INTO JADE AND WORE IT AS PROTECTION AGAINST ENEMIES!
I much prefer that sentiment.
Remind me— how will I know when seventeen years have passed?
YOU HAVE AN INTERNAL MOLECULAR CLOCK THAT HELPS YOU NOTE THE PASSAGE OF TIME.
YOU PROBABLY ALSO GET CLUES FROM THE CHANGING COMPOSITION OF MY SAP AS I GO THROUGH MY SEASONAL CYCLES.
BUT THE KEY TO THE DAY YOU'LL EMERGE IS WHEN THE SOIL TEMPERATURE REACHES 64 DEGREES FAHRENHEIT — THAT'S 18 DEGREES CELSIUS.
YOU KNOW, IT'S IRONIC, BUT IN MANY WAYS YOU ARE MORE MATURE AT THIS PHASE OF YOUR LIFE THAN YOU ARE AS AN ADULT...
How so?
WHEN YOU EMERGE AND TRANSFORM, ALL YOU WANT TO DO IS FORNICATE. WE COULD NEVER HAVE THESE SCINTILLATING CONVERSATIONS.
What's "fornicate" mean?
COPULATE.
?
HAVE SEX.
Oh. Yuck.


Tree?
YES, MY FRIEND?
I don't know what I'd do without you...
I don't want our time together to be over...I love—
NOW, NOW—
LET'S JUST MAKE THE MOST OF THESE NEXT FEW YEARS—
SHALL WE SING A SONG?
RATA
BRZZZ
BRRZZ
RAT-TA
Wow—people may complain about the 100-decibel sound cicadas make...
but humans give us plenty of competition for noisiest creature!
Oh—I just got too warm.
Oh my, I really have to get out of here...
I need some air—
Tree, has it been seventeen years?
Is this it??
Tree—you were so right! The time just evaporated!
-=Umph!=
It's just a question of climbing out—
=Umph!=
I still need your help, Tree!
=Umph!=
Tree? Are you there?
Tree??

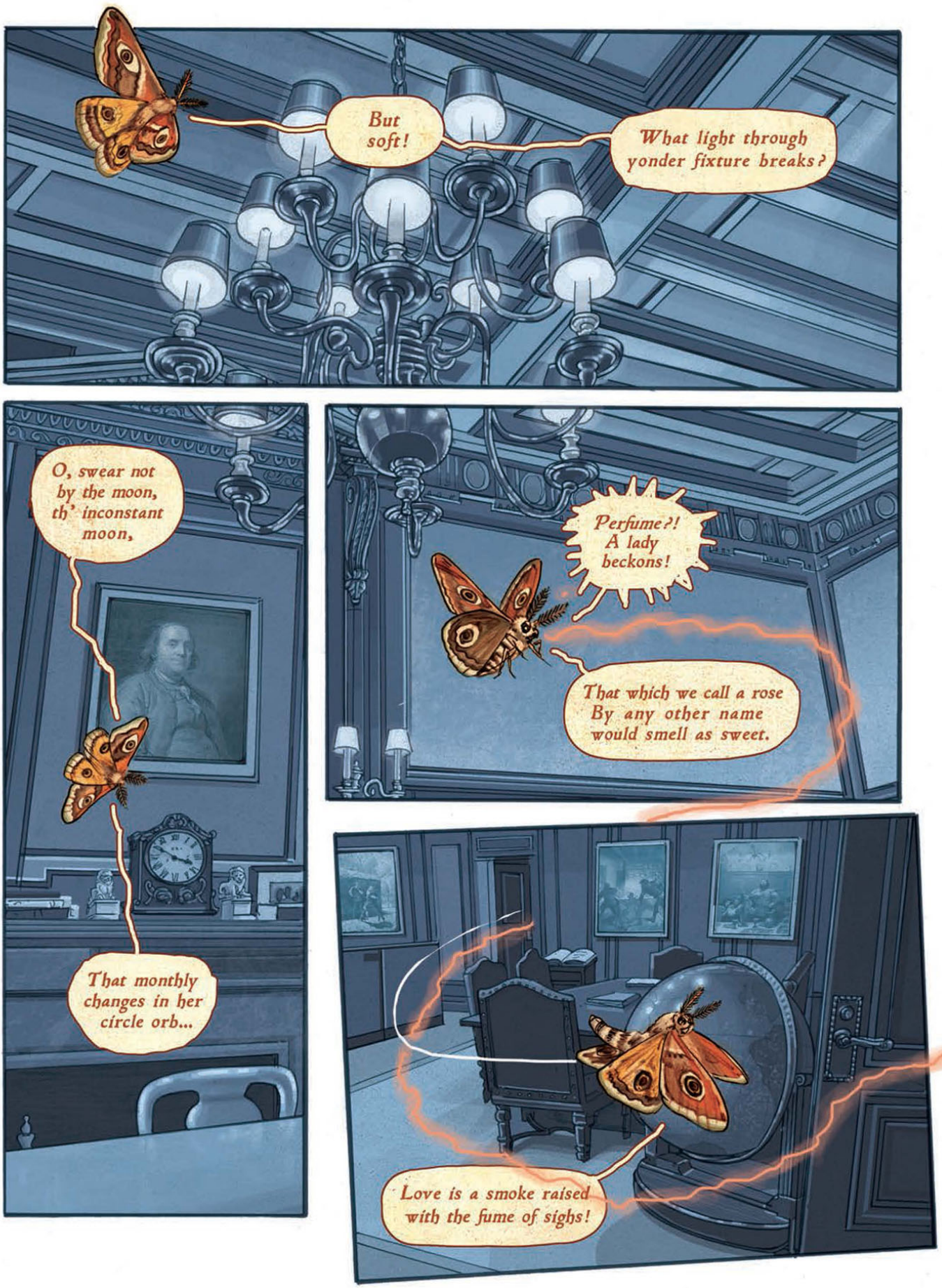
DOLLAR TREE
$1
$1
$
P
ARKING

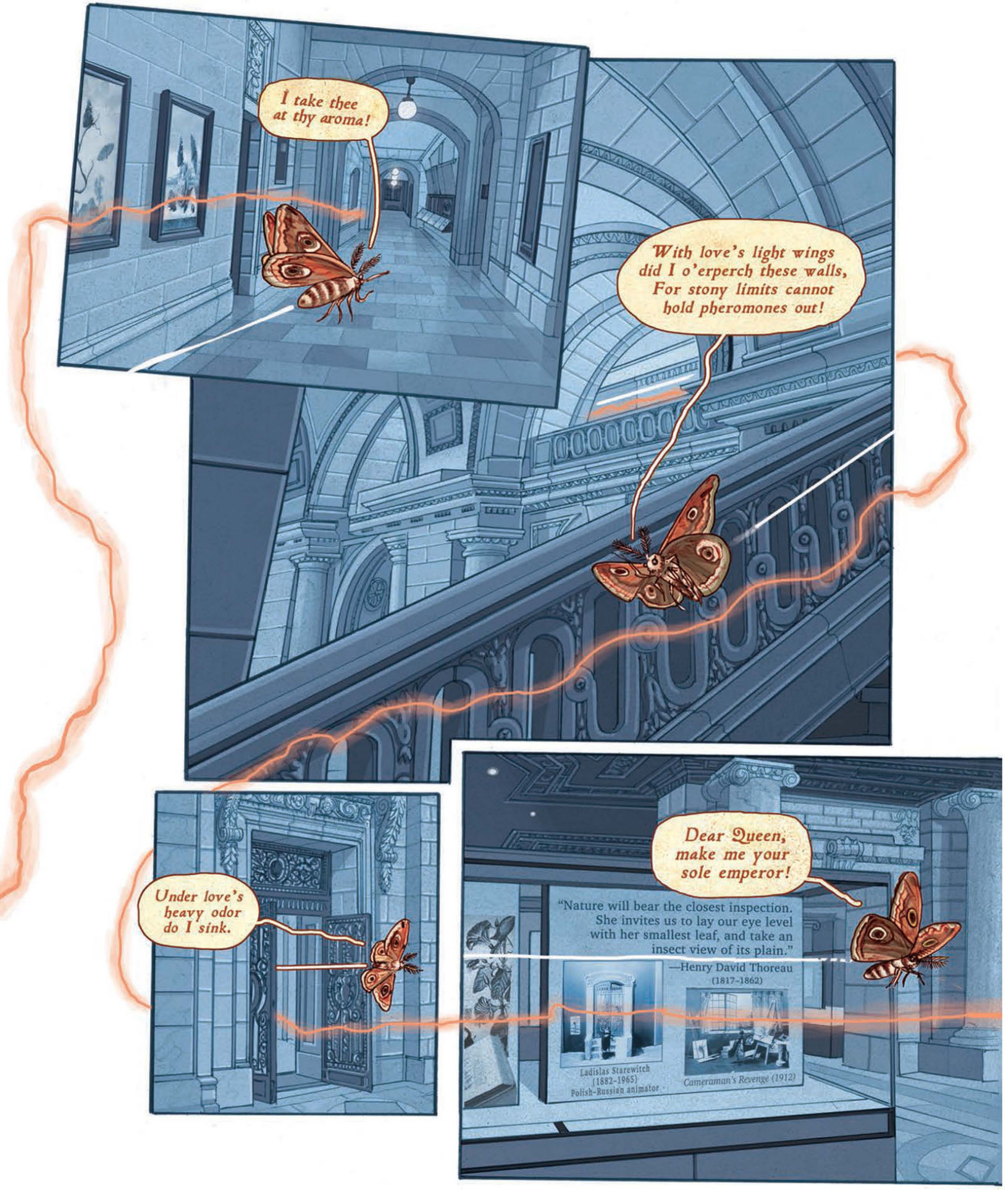
Tree!!

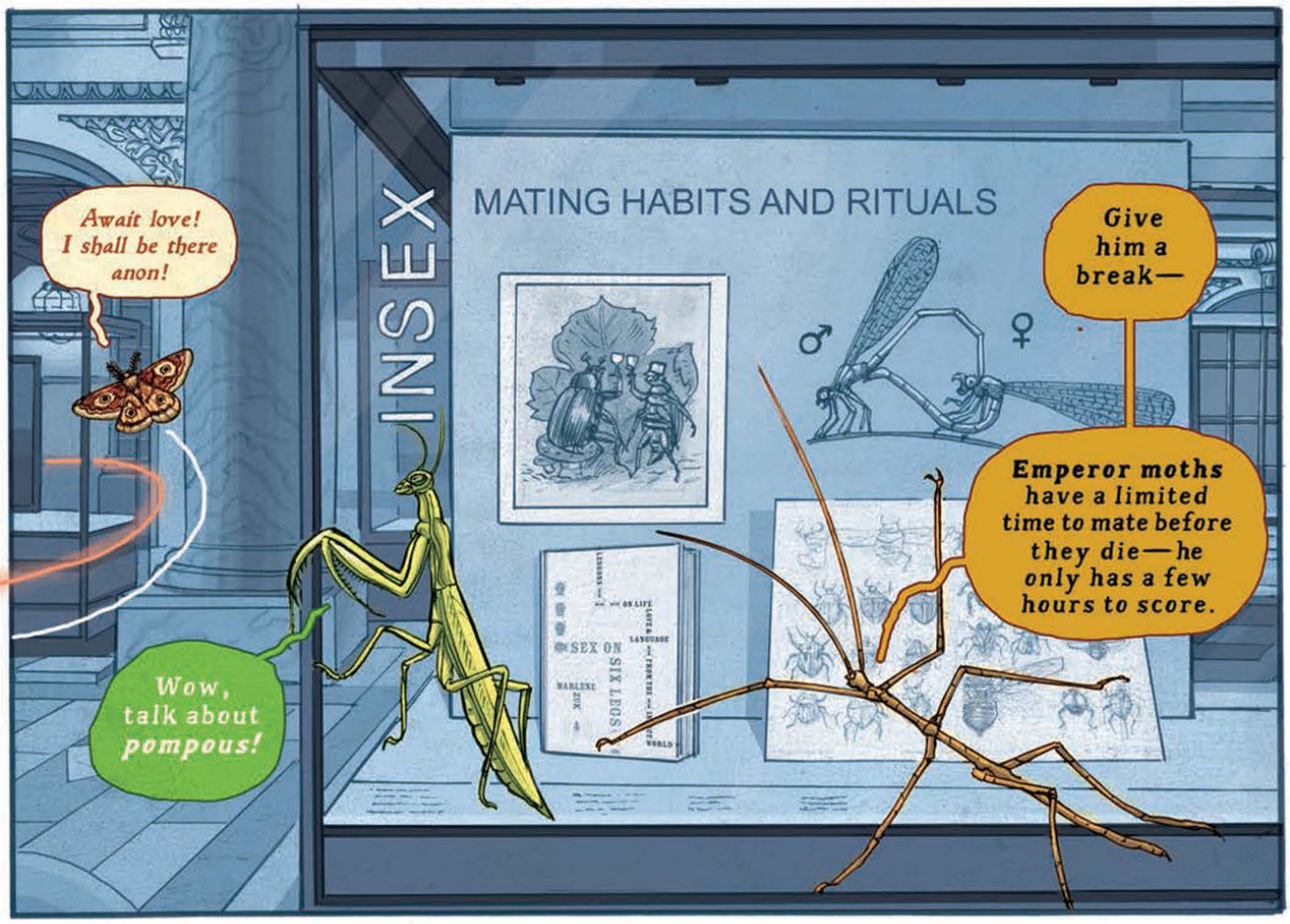
AHHH! Oh. I just had the most horrific dream!
I was trapped underground and I...
Never mind.
As an adult, you've got more important things to think about...

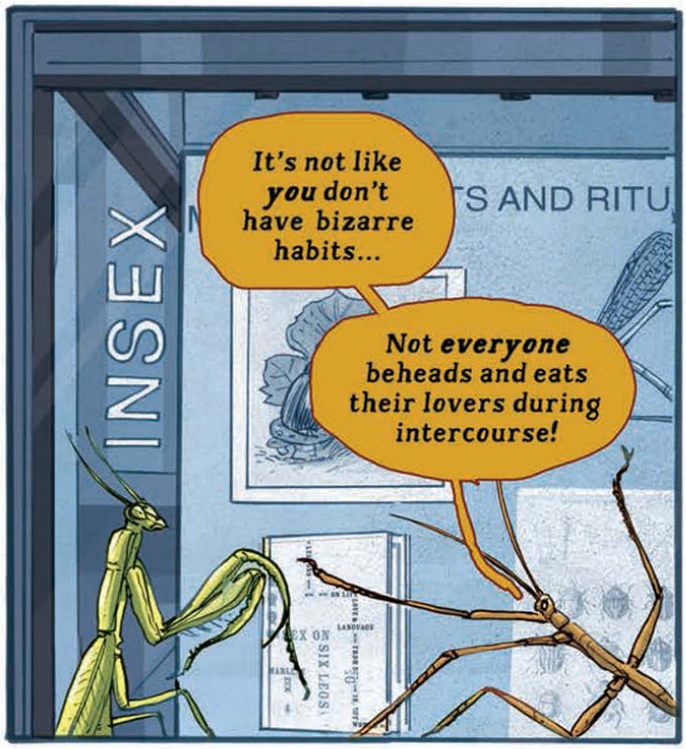

S-S-S-
E-E-E-
X-X-X!

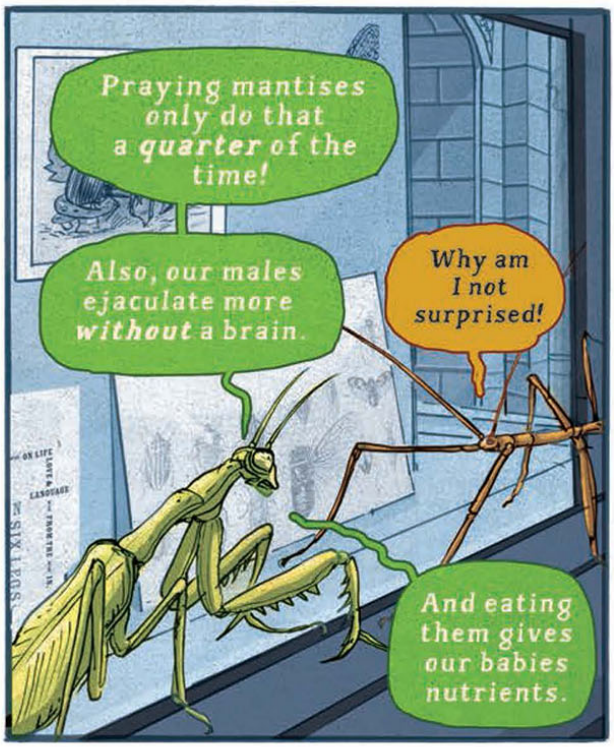
***Mothra* was released in Japan on July 30, 1961. An English dubbed version hit screens in the United States in 1962.**

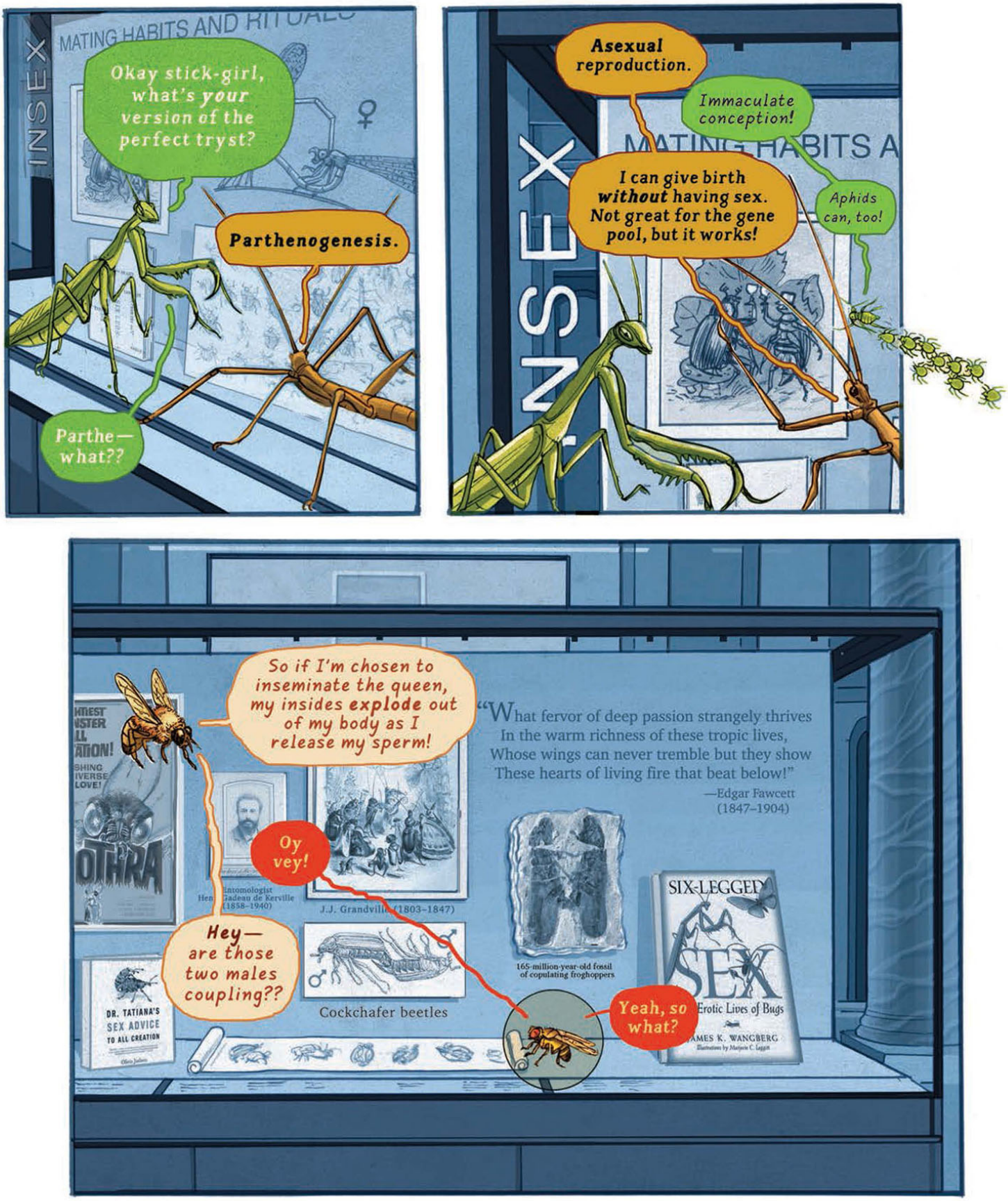

But soft!
What light through yonder fixture breaks?
O, swear not by the moon, th' inconstant moon,
That monthly changes in her circle orb...
Perfume?! A lady beckons!
That which we call a rose By any other name would smell as sweet.
Love is a smoke raised with the fume of sighs!

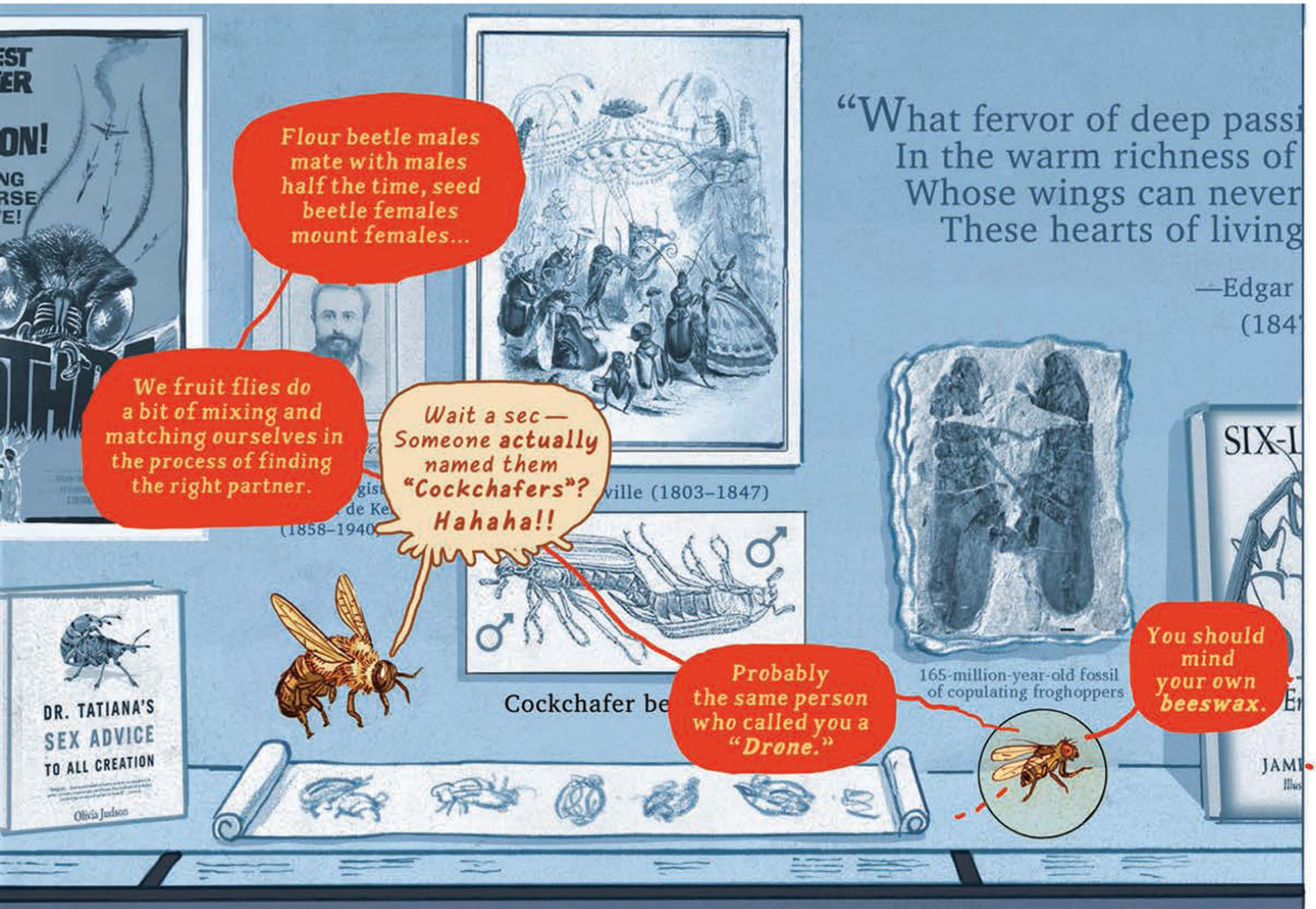

I take thee at thy aroma!
With love's light wings did I o'erperch these walls, For stony limits cannot hold pheromones out!
Under love's heavy odor do I sink.
Dear Queen, make me your sole emperor!
"Nature will bear the closest inspection. She invites us to lay our eye level with her smallest leaf, and take an insect view of its plain."
—Henry David Thoreau (1817–1862)
Ladislas Starewitch (1882–1965) Polish-Russian animator
Cameraman's Revenge (1912)


Await love! I shall be there anon!
INSEX
MATING HABITS AND RITUALS
♂
♀
Give him a break—
Emperor moths have a limited time to mate before they die—he only has a few hours to score.
Wow, talk about pompous!
SEX ON SIX LEGS


INSEX
It's not like you don't have bizarre habits...
Not everyone beheads and eats their lovers during intercourse!

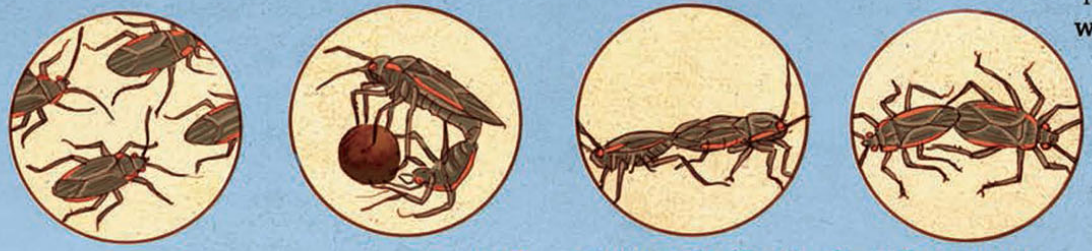

Praying mantises only do that a quarter of the time!
Also, our males ejaculate more without a brain.
Why am I not surprised!
And eating them gives our babies nutrients.


INSEX
MATING HABITS AND RITUALS
Okay stick-girl, what's your version of the perfect tryst?
♀
Parthenogenesis.
Parthe— what??
Asexual reproduction.
Immaculate conception!
I can give birth without having sex. Not great for the gene pool, but it works!
Aphids can, too!
So if I'm chosen to inseminate the queen, my insides explode out of my body as I release my sperm!
"What fervor of deep passion strangely thrives
In the warm richness of these tropic lives,
Whose wings can never tremble but they show
These hearts of living fire that beat below!"
—Edgar Fawcett
(1847–1904)
Oy vey!
Hey— are those two males coupling??
Entomologist Henri Gadeau de Kerville (1858–1940)
J.J. Grandville (1803–1847)
165-million-year-old fossil of copulating froghoppers
Cockchafer beetles
Yeah, so what?
SIX-LEGGED SEX
Erotic Lives of Bugs
JAMES K. WANGBERG
Illustrations by Marjorie C. Leggitt
DR. TATIANA'S SEX ADVICE TO ALL CREATION
OTHRA


Flour beetle males mate with males half the time, seed beetle females mount females...
We fruit flies do a bit of mixing and matching ourselves in the process of finding the right partner.
Wait a sec— Someone actually named them "Cockchafers"? Hahaha!!
"What fervor of deep passi
In the warm richness of
Whose wings can never
These hearts of living
—Edgar
(184
ville (1803–1847)
(1858–1940
Cockchafer be
165-million-year-old fossil of copulating froghoppers
Probably the same person who called you a "Drone."
You should mind your own beeswax.
DR. TATIANA'S SEX ADVICE TO ALL CREATION
Olivia Judson
SIX-L
JAM

Soapberry bugs

To ward off competitors, the males will couple with a female until she is ready to lay eggs. Sometimes for **weeks.**



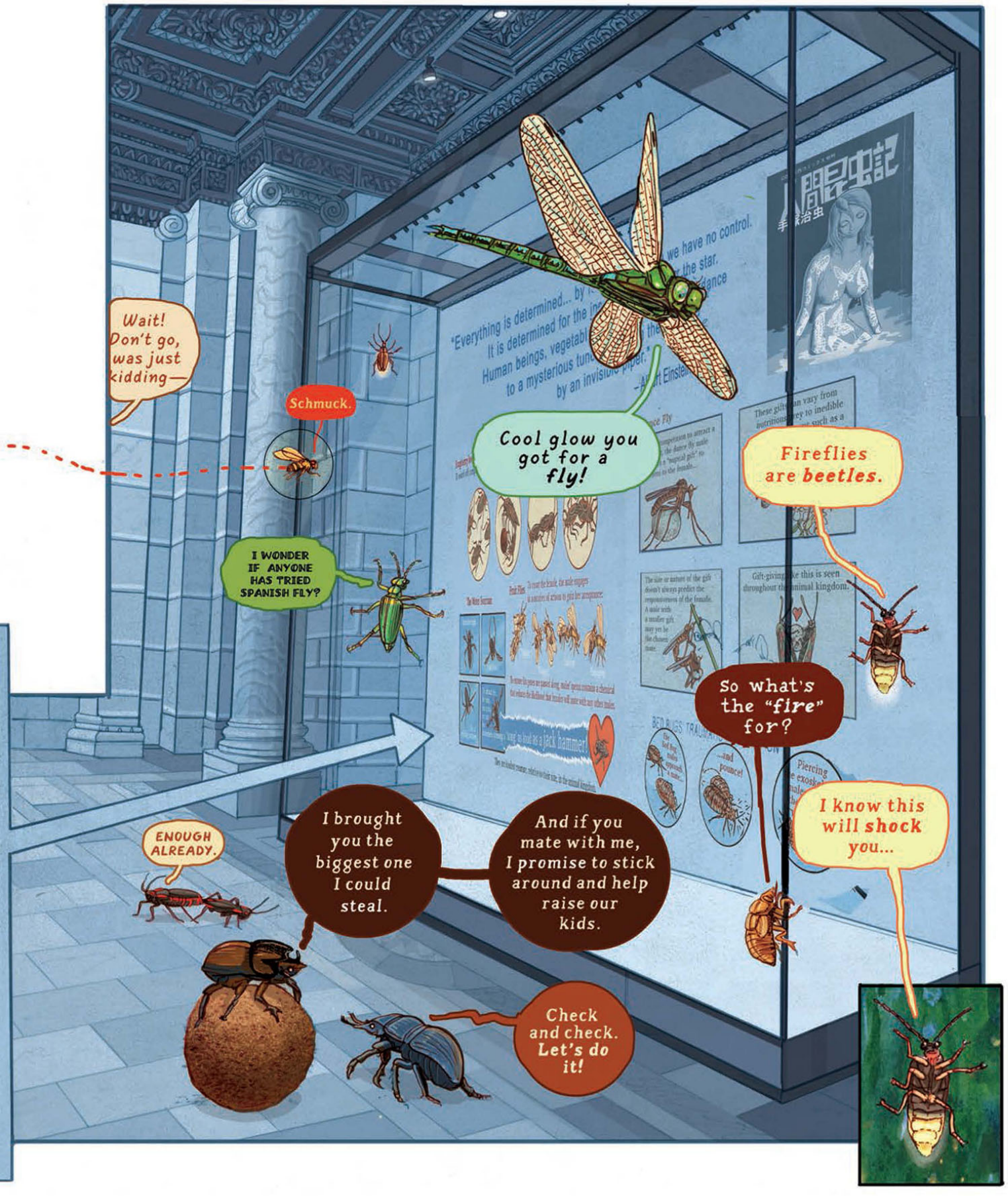
The Water Boatman

Searches high...
and low...
for a willing partner.
To attract her, he rubs his penis across his abdomen creating a "song" as loud as a jack hammer!

They are the loudest creature, relative to their size, in the animal kingdom.

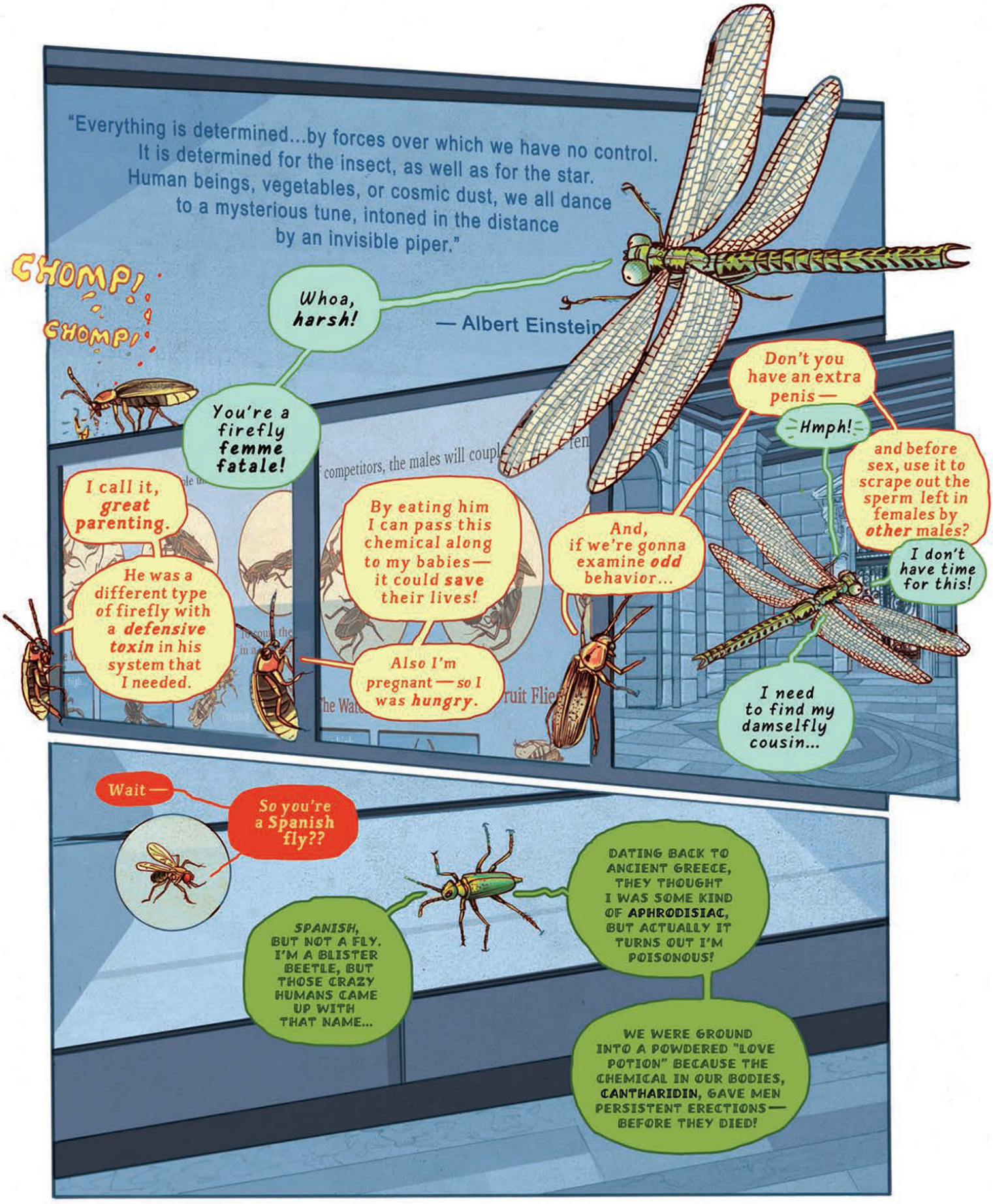
Fruit Flies To court the female, the male engages in a number of actions to gain her acceptance:

To ensure his genes are passed along, males' sperm contains a chemical that reduces the likelihood that females will mate with any other males.


Wait! Don't go, was just kidding—
Schmuck.
I WONDER IF ANYONE HAS TRIED SPANISH FLY?
Cool glow you got for a fly!
Fireflies are beetles.
So what's the "fire" for?
I know this will shock you...
ENOUGH ALREADY.
I brought you the biggest one I could steal.
And if you mate with me, I promise to stick around and help raise our kids.
Check and check. Let's do it!

We use it to attract mates.
Our blinking lights are like Morse code telegraphing our desire.
It comes from combining two chemicals in my system that glow when mixed with air.
If my light is bright and sustained, she'll know my genes are potent and she'll signal her interest.

And then we consummate the—
AHHH!
CRUNCH!
CHOMP!
CHOMP!


"Everything is determined...by forces over which we have no control. It is determined for the insect, as well as for the star. Human beings, vegetables, or cosmic dust, we all dance to a mysterious tune, intoned in the distance by an invisible piper."
— Albert Einstein
CHOMP!
CHOMP!
Whoa, harsh!
You're a firefly femme fatale!
I call it, great parenting.
He was a different type of firefly with a defensive toxin in his system that I needed.
By eating him I can pass this chemical along to my babies— it could save their lives!
Also I'm pregnant — so I was hungry.
competitors, the males will
Don't you have an extra penis —
Hmph!
and before sex, use it to scrape out the sperm left in females by other males?
I don't have time for this!
And, if we're gonna examine odd behavior...
I need to find my damselfly cousin...
Wait —
So you're a Spanish fly??
SPANISH, BUT NOT A FLY. I'M A BLISTER BEETLE, BUT THOSE CRAZY HUMANS CAME UP WITH THAT NAME...
DATING BACK TO ANCIENT GREECE, THEY THOUGHT I WAS SOME KIND OF APHRODISIAC, BUT ACTUALLY IT TURNS OUT I'M POISONOUS!
WE WERE GROUND INTO A POWDERED "LOVE POTION" BECAUSE THE CHEMICAL IN OUR BODIES, CANTHARIDIN, GAVE MEN PERSISTENT ERECTIONS— BEFORE THEY DIED!

Dance Fly

In the competition to attract a partner, the dance fly male creates a "nuptial gift" to present to the female.

These gifts can vary from nutritious prey to inedible items such as a leaf or a stone, wrapped in a silk balloon.

The size or nature of the gift doesn't always predict the responsiveness of the female. A male with a smaller gift may yet be the chosen mate.

Gift-giving like this is seen throughout the animal kingdom.

Might insects feel romantic emotions like humans?

BED BUGS' TRAUMATIC INSEMINATION

The Bed Bug males approach a mate...

and pounce!

Piercing the exoskeleton, males inject their sperm.

'Scuse me, guys?

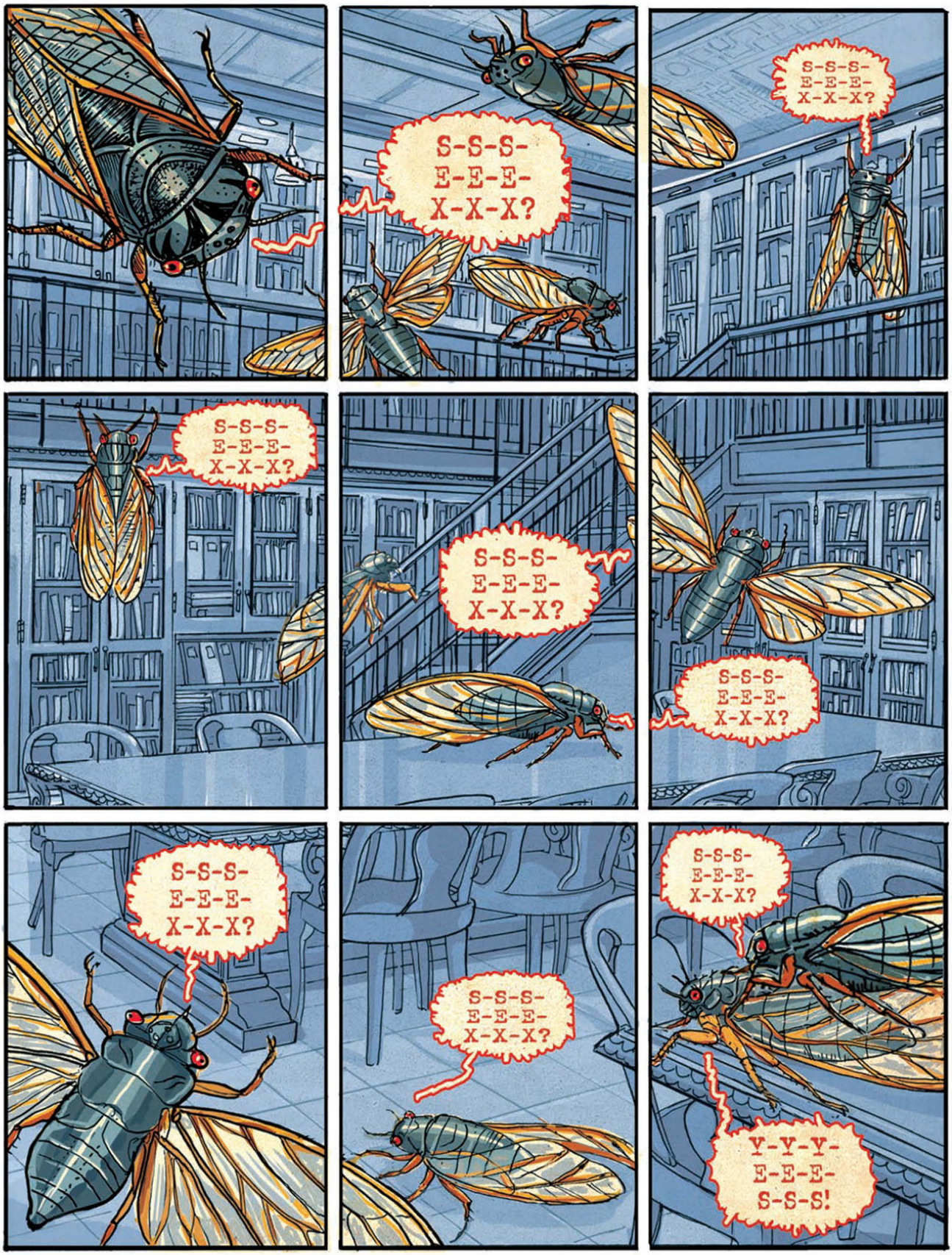
Have you seen my brother? He...

And then I'm going to... <whisper whisper>

MMM, go on... Tee-hee

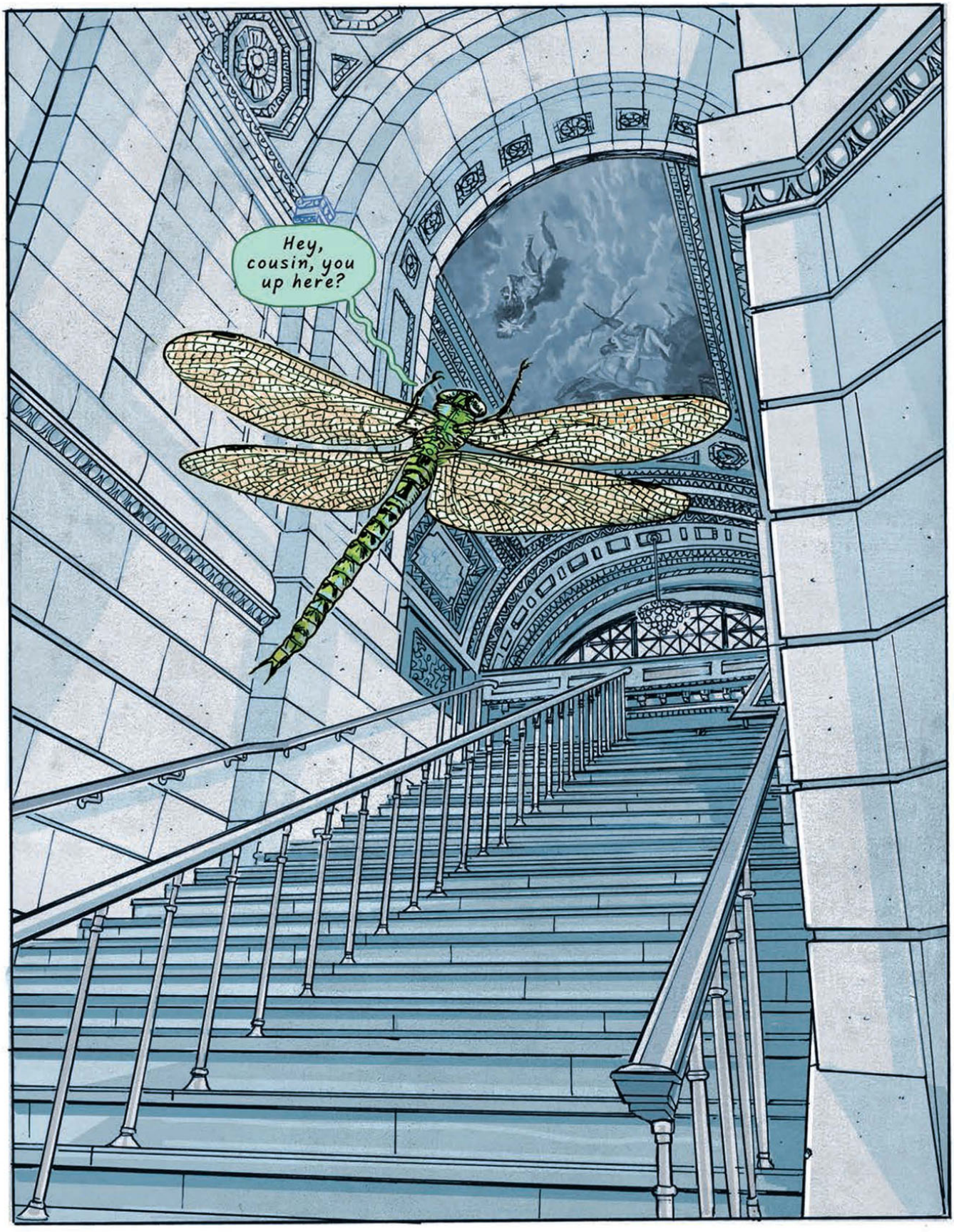
Oh. Never mind.

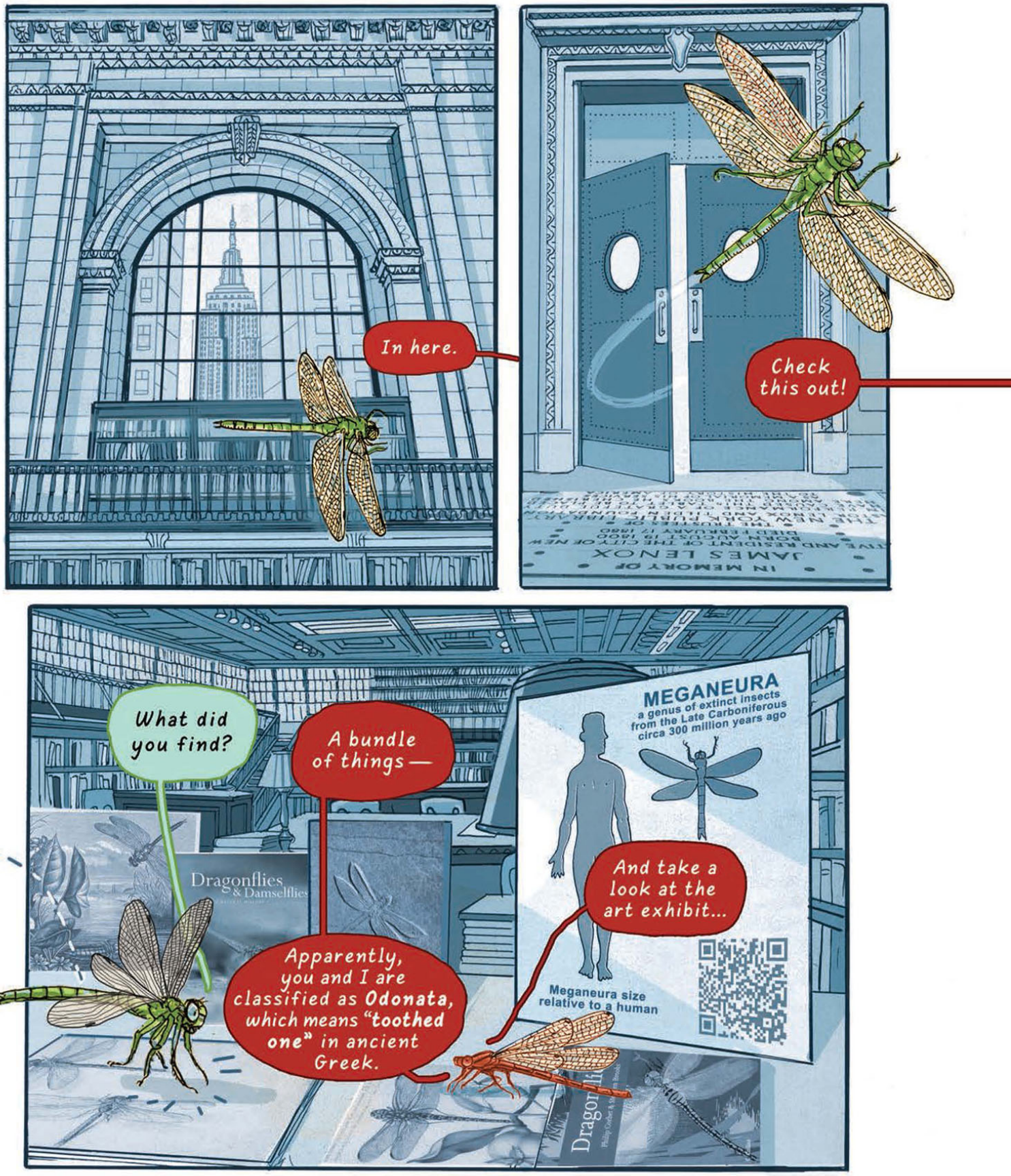
I'm just concerned that he won't find love before he dies...

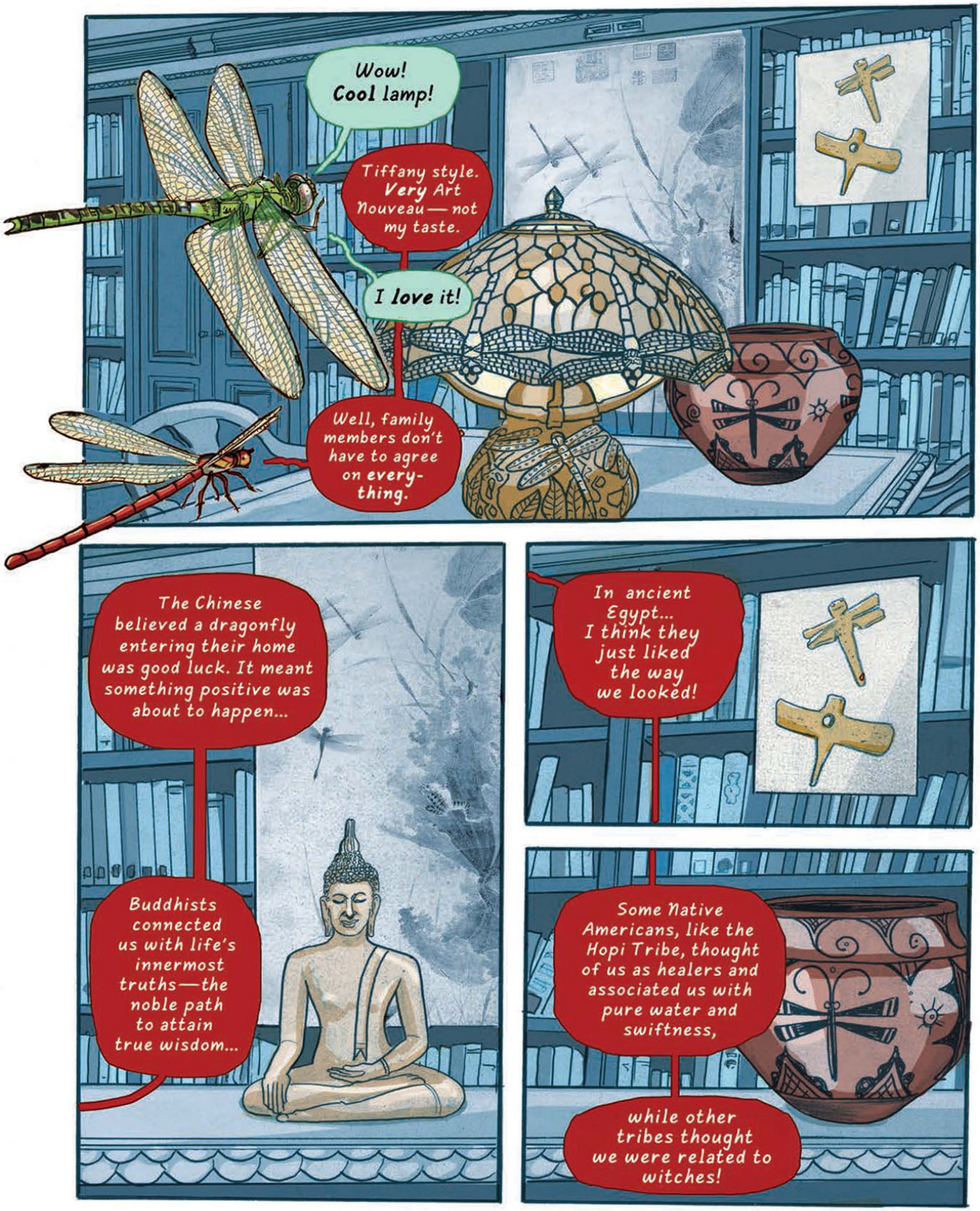

S-S-S-
E-E-E-
X-X-X?
S-S-S-
E-E-E-
X-X-X?
S-S-S-
E-E-E-
X-X-X?
S-S-S-
E-E-E-
X-X-X?
S-S-S-
E-E-E-
X-X-X?
S-S-S-
E-E-E-
X-X-X?
S-S-S-
E-E-E-
X-X-X?
V-V-V-
E-E-E-
S-S-S!

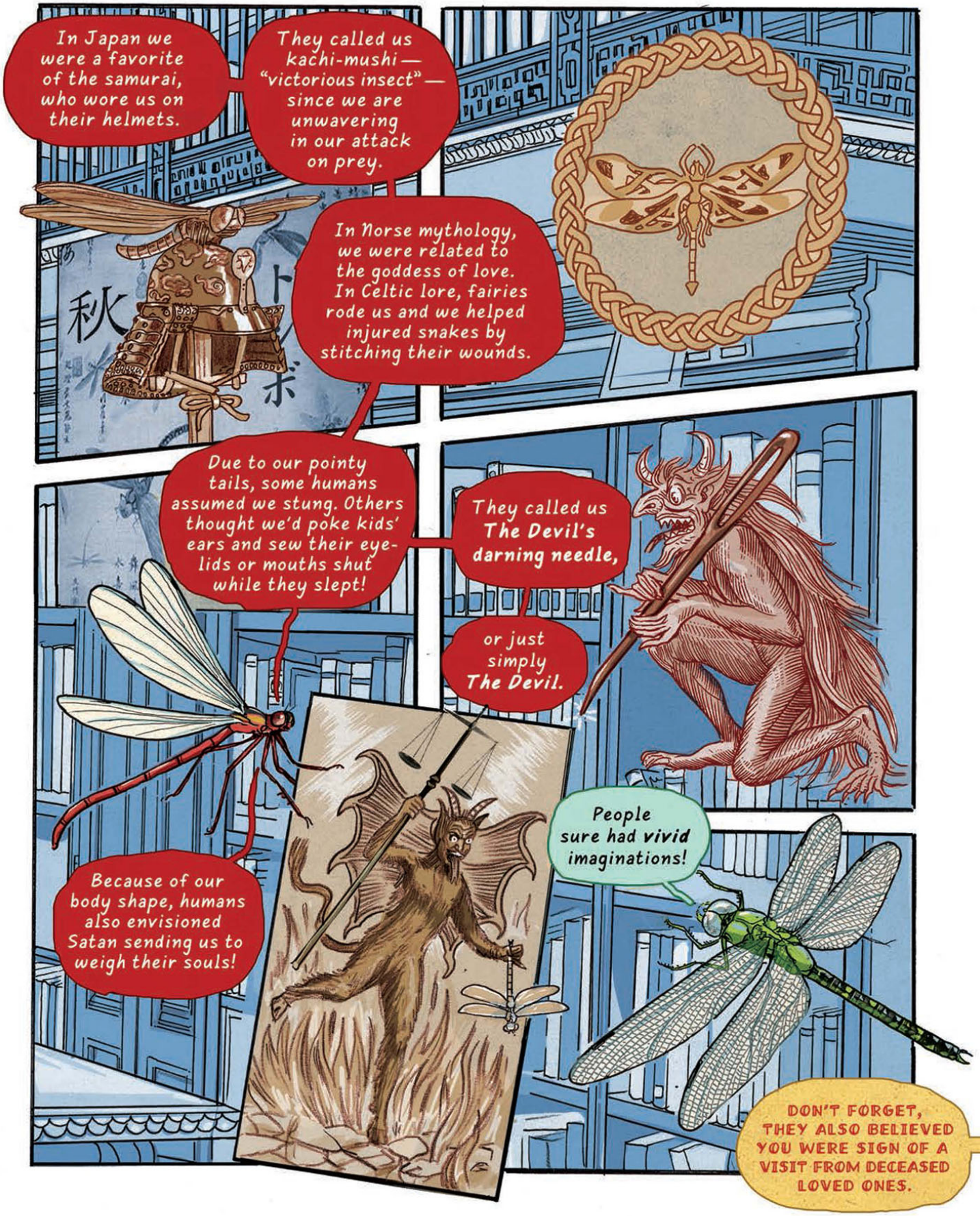
"DDT is good for me-e-e!"
The great expectations held for DDT have been realized. During 1946, exhaustive scientific tests have shown
one of the country's largest producers of this amazing insecticide. Today, everyone can enjoy added comfort,

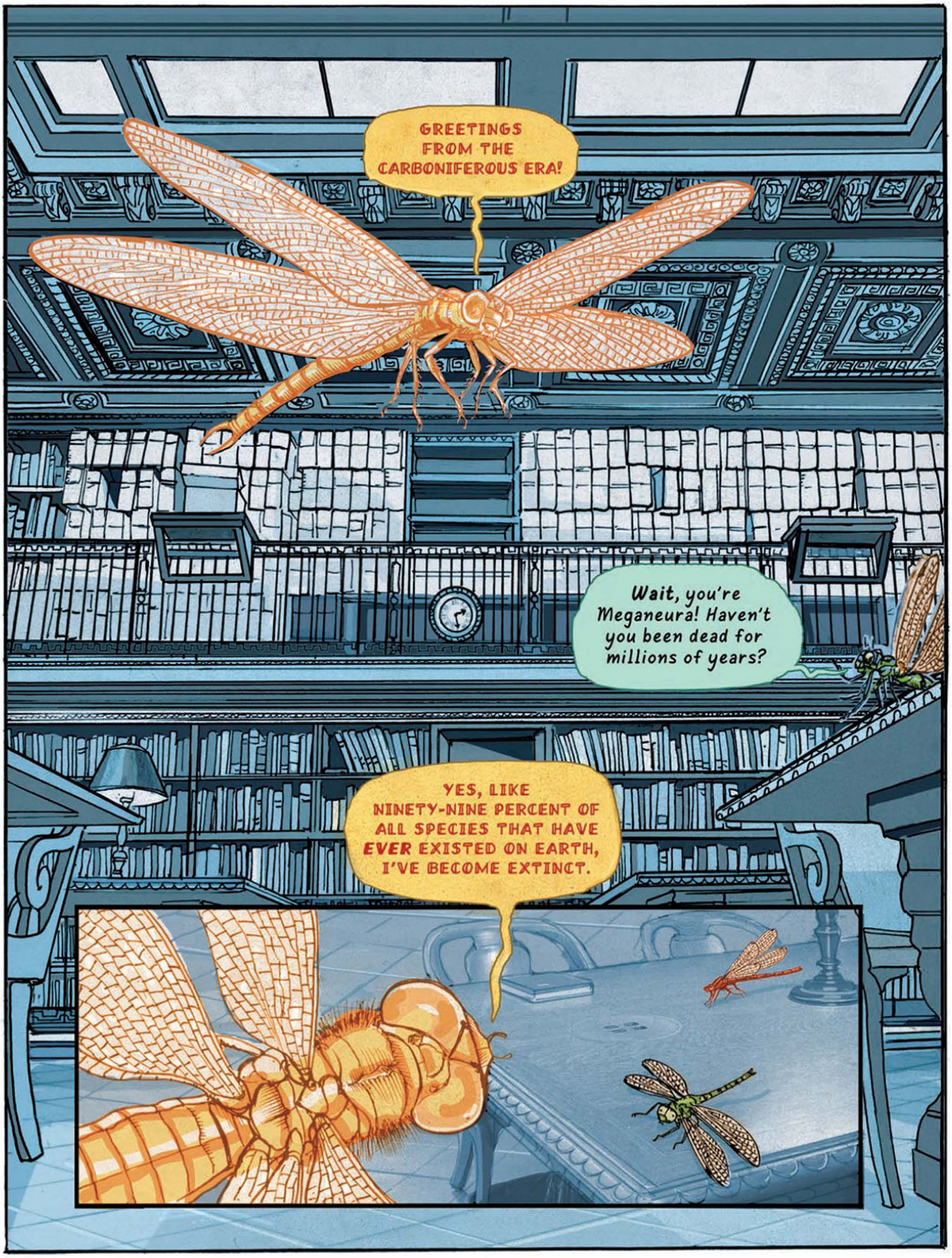
The insecticidal action of DDT (dichloro-diphenyl-trichloroethane) was discovered by the Swiss chemist Paul Hermann Müller in 1939, for which he was awarded a Nobel Prize. DDT was widely promoted by government and industry as a safe pesticide, but later identified as a cause of cancer in humans and devastating to the entire ecosystem. After public outcry, DDT was finally banned in the USA in 1972 but continued to be sold abroad.

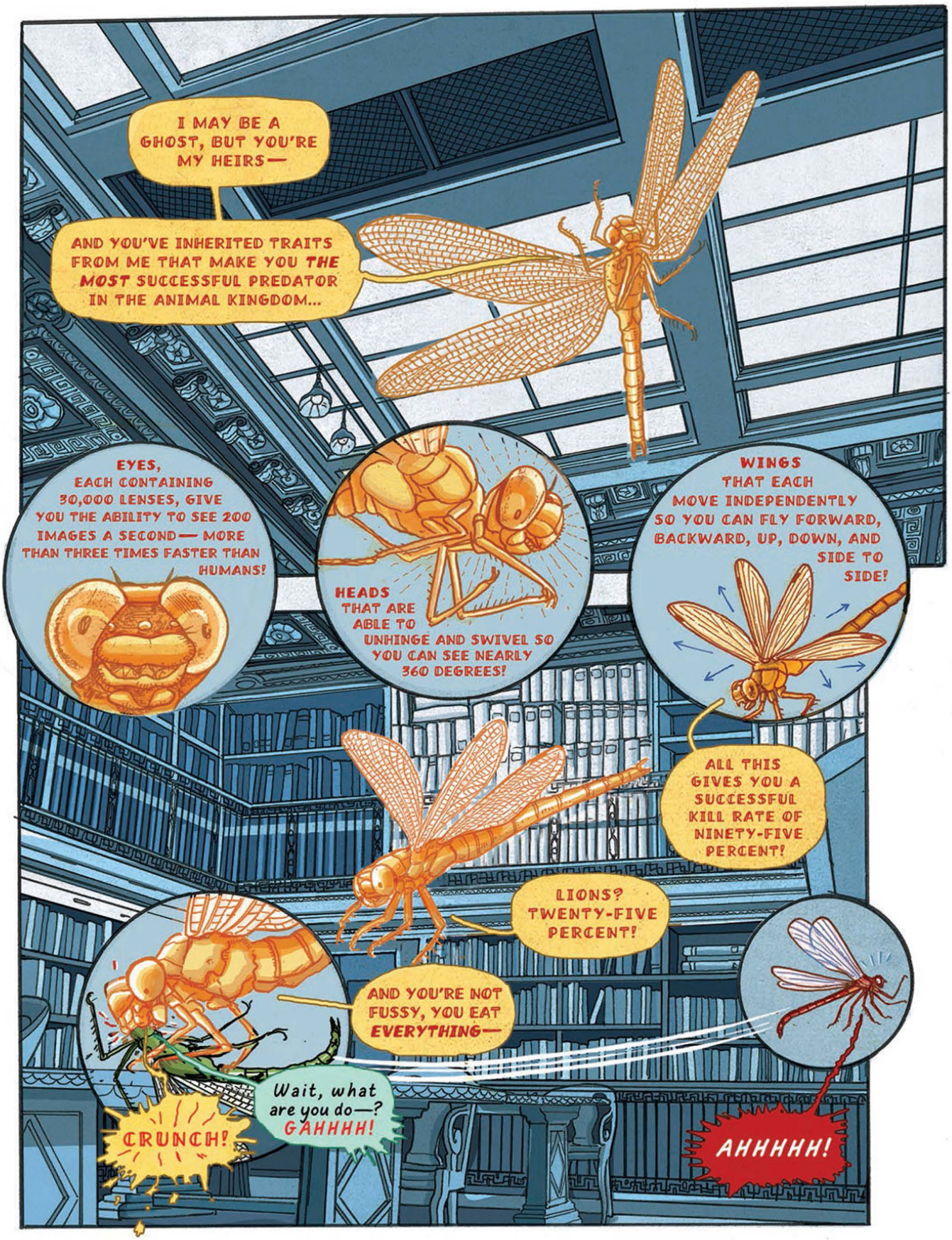

Hey, cousin, you up here?

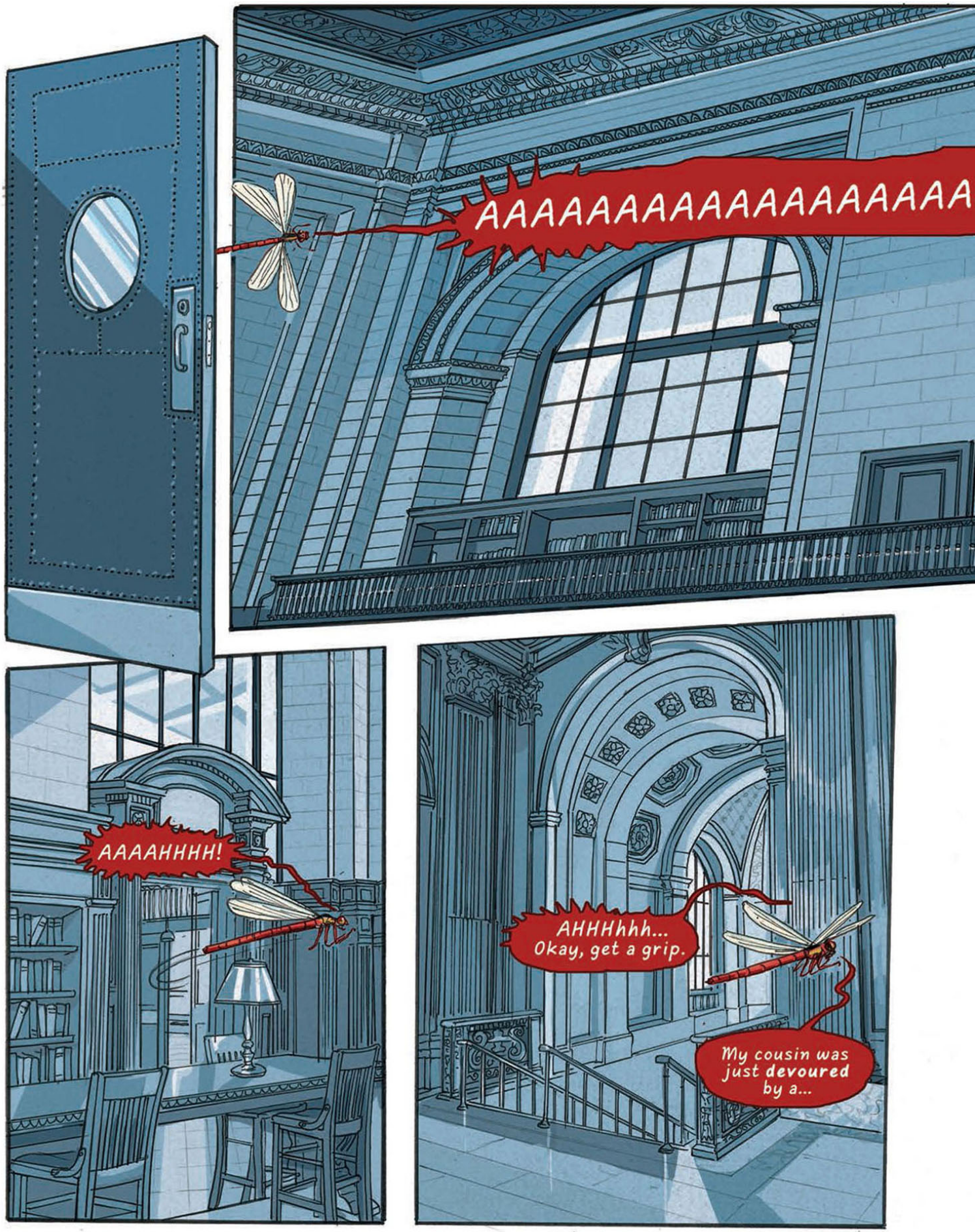

In here.
Check this out!
What did you find?
A bundle of things—
Apparently, you and I are classified as Odonata, which means "toothed one" in ancient Greek.
MEGANEURA
a genus of extinct insects from the Late Carboniferous circa 300 million years ago
Meganeura size relative to a human
And take a look at the art exhibit...
Dragonflies & Damselflies

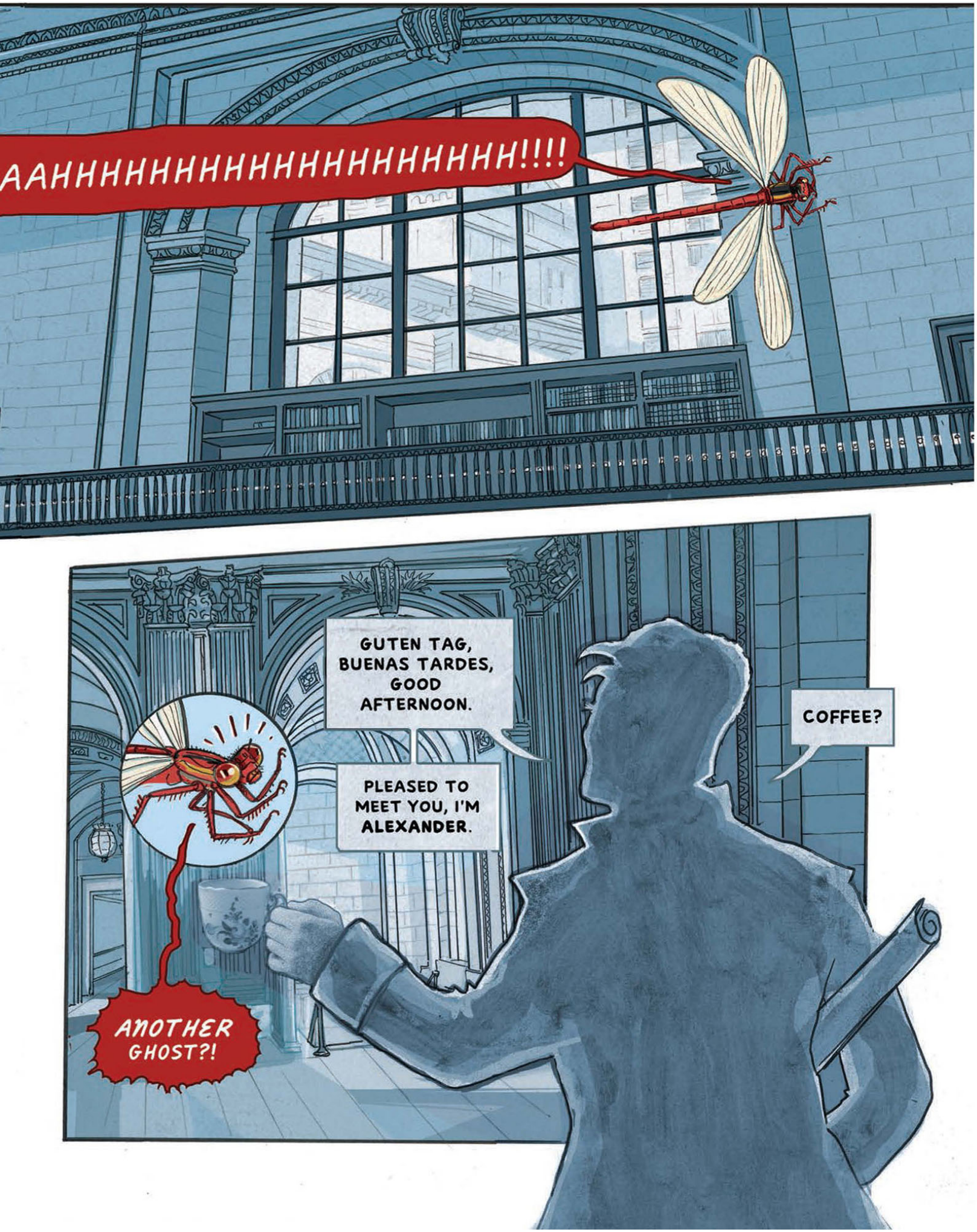

Wow! Cool lamp!
Tiffany style. Very Art Nouveau — not my taste.
I love it!
Well, family members don't have to agree on every-thing.
The Chinese believed a dragonfly entering their home was good luck. It meant something positive was about to happen...
Buddhists connected us with life's innermost truths — the noble path to attain true wisdom...
In ancient Egypt... I think they just liked the way we looked!
Some Native Americans, like the Hopi Tribe, thought of us as healers and associated us with pure water and swiftness,
while other tribes thought we were related to witches!

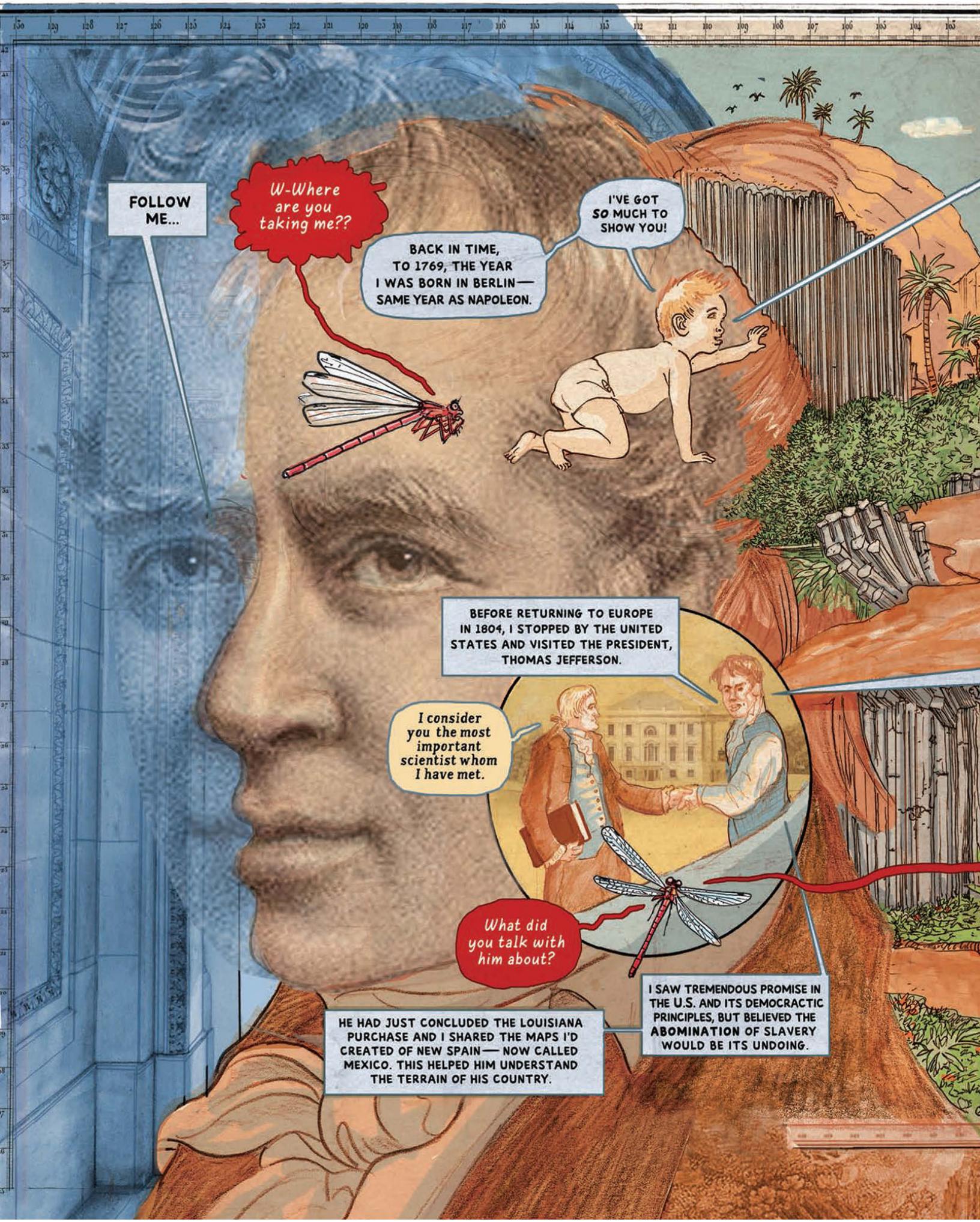

In Japan we were a favorite of the samurai, who wore us on their helmets.
They called us kachi-mushi — "victorious insect" — since we are unwavering in our attack on prey.
In Norse mythology, we were related to the goddess of love. In Celtic lore, fairies rode us and we helped injured snakes by stitching their wounds.
Due to our pointy tails, some humans assumed we stung. Others thought we'd poke kids' ears and sew their eyelids or mouths shut while they slept!
They called us The Devil's darning needle,
or just simply The Devil.
Because of our body shape, humans also envisioned Satan sending us to weigh their souls!
People sure had vivid imaginations!
DON'T FORGET, THEY ALSO BELIEVED YOU WERE SIGN OF A VISIT FROM DECEASED LOVED ONES.

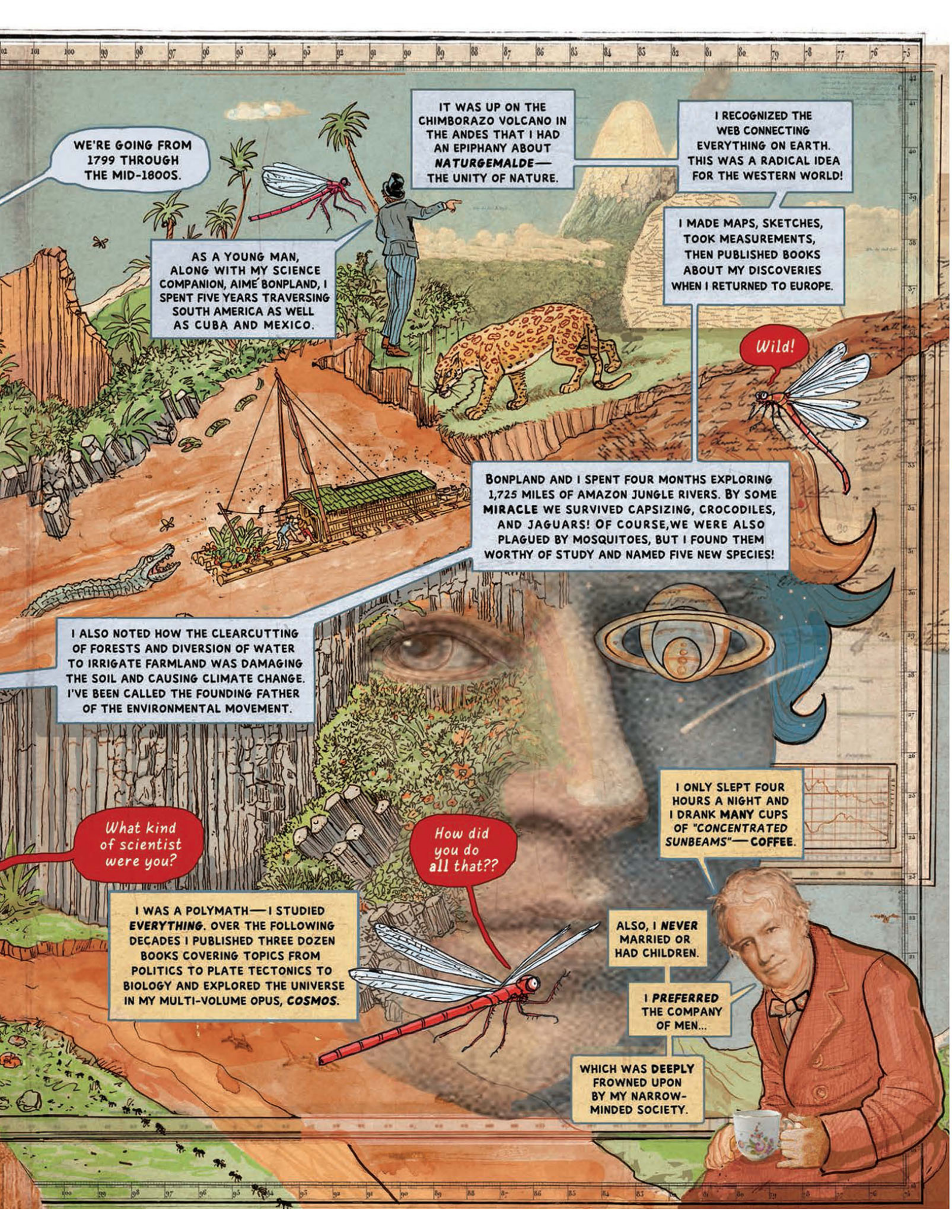

GREETINGS FROM THE CARBONIFEROUS ERA!
Wait, you're Meganeura! Haven't you been dead for millions of years?
YES, LIKE NINETY-NINE PERCENT OF ALL SPECIES THAT HAVE EVER EXISTED ON EARTH, I'VE BECOME EXTINCT.

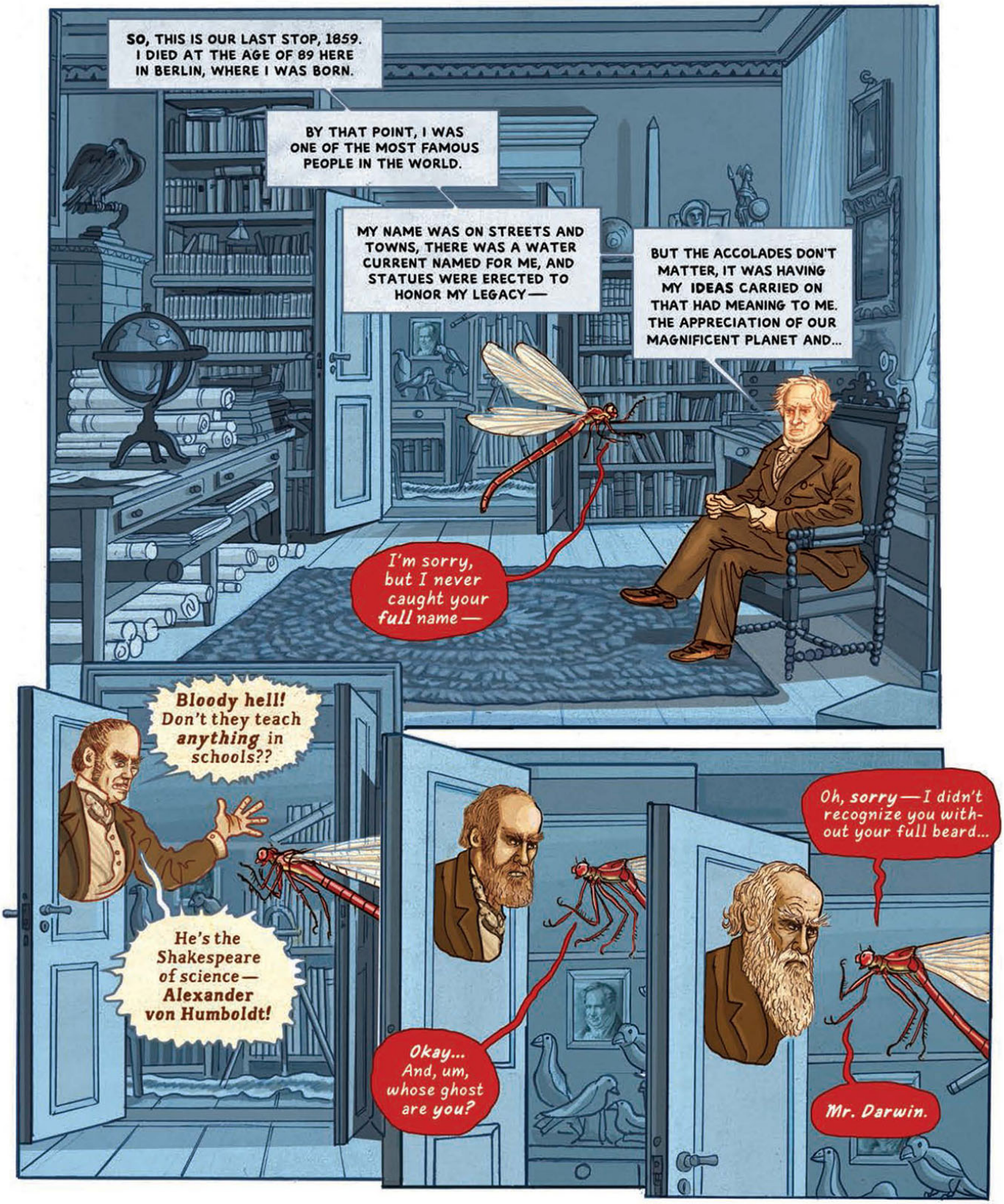

I MAY BE A GHOST, BUT YOU'RE MY HEIRS—
AND YOU'VE INHERITED TRAITS FROM ME THAT MAKE YOU *THE MOST* SUCCESSFUL PREDATOR IN THE ANIMAL KINGDOM...
EYES, EACH CONTAINING 30,000 LENSES, GIVE YOU THE ABILITY TO SEE 200 IMAGES A SECOND— MORE THAN THREE TIMES FASTER THAN HUMANS!
HEADS THAT ARE ABLE TO UNHINGE AND SWIVEL SO YOU CAN SEE NEARLY 360 DEGREES!
WINGS THAT EACH MOVE INDEPENDENTLY SO YOU CAN FLY FORWARD, BACKWARD, UP, DOWN, AND SIDE TO SIDE!
ALL THIS GIVES YOU A SUCCESSFUL KILL RATE OF NINETY-FIVE PERCENT!
LIONS? TWENTY-FIVE PERCENT!
AND YOU'RE NOT FUSSY, YOU EAT *EVERYTHING*—
Wait, what are you do—? GAHHHH!
CRUNCH!
AHHHHH!

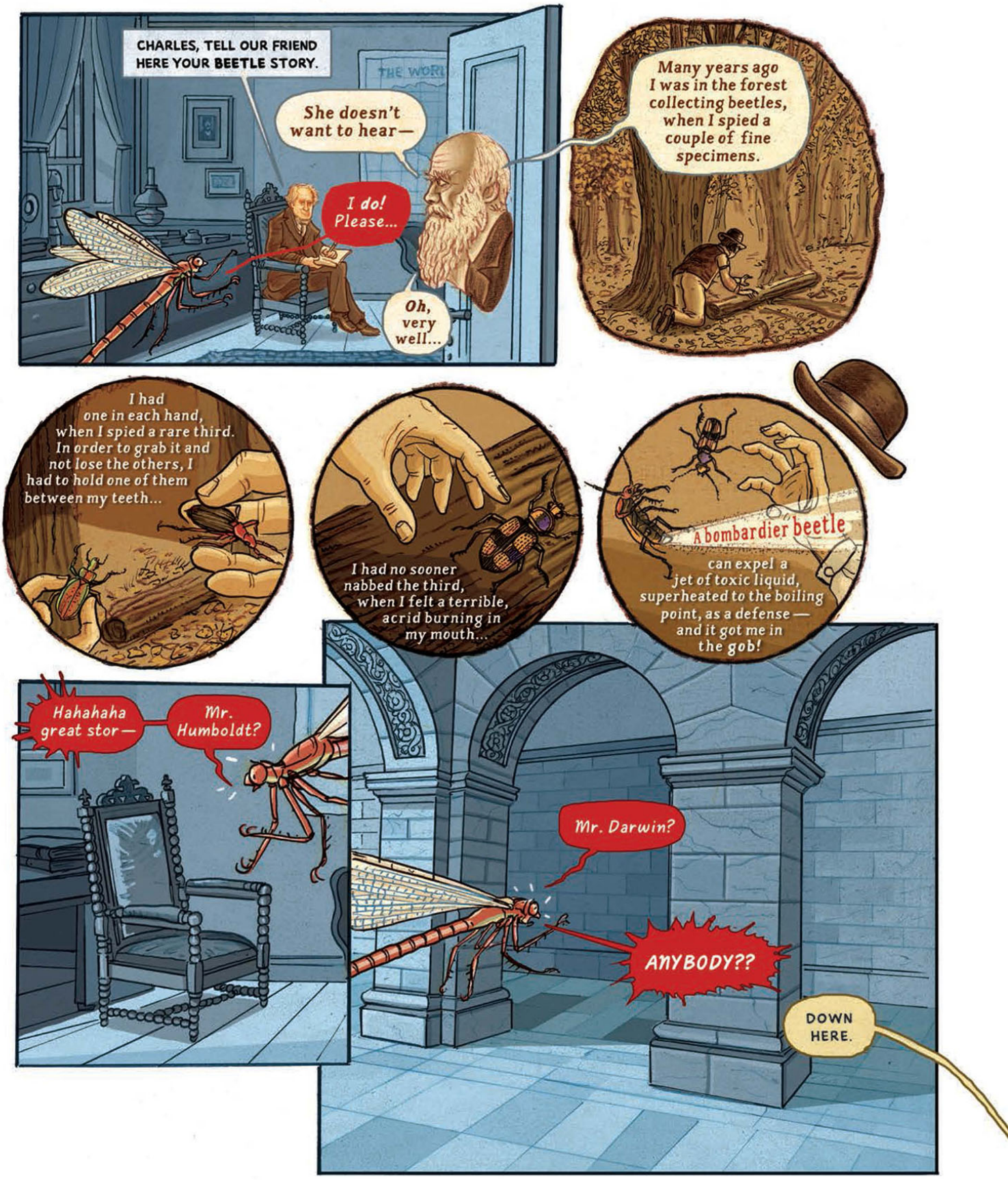

AAAAAAAAAAAAAAAAAAA
AAAAHHHH!
AHHHhhh... Okay, get a grip.
My cousin was just devoured by a...

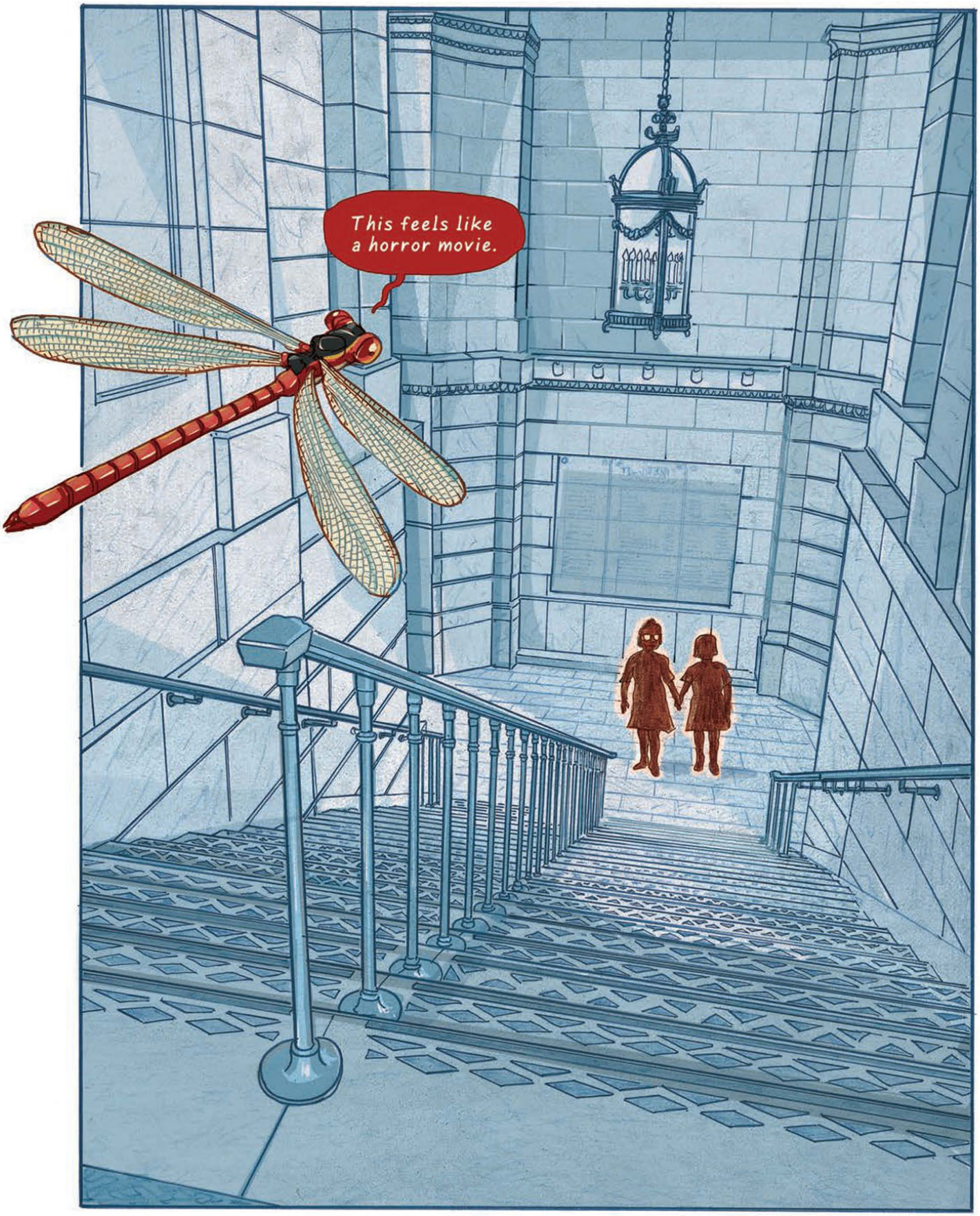

AAHHHHHHHHHHHHHHHHHH!!!!
GUTEN TAG, BUENAS TARDES, GOOD AFTERNOON.
PLEASED TO MEET YOU, I'M ALEXANDER.
COFFEE?
ANOTHER GHOST?!


FOLLOW ME...
W-Where are you taking me??
BACK IN TIME, TO 1769, THE YEAR I WAS BORN IN BERLIN— SAME YEAR AS NAPOLEON.
I'VE GOT SO MUCH TO SHOW YOU!
BEFORE RETURNING TO EUROPE IN 1804, I STOPPED BY THE UNITED STATES AND VISITED THE PRESIDENT, THOMAS JEFFERSON.
I consider you the most important scientist whom I have met.
What did you talk with him about?
HE HAD JUST CONCLUDED THE LOUISIANA PURCHASE AND I SHARED THE MAPS I'D CREATED OF NEW SPAIN— NOW CALLED MEXICO. THIS HELPED HIM UNDERSTAND THE TERRAIN OF HIS COUNTRY.
I SAW TREMENDOUS PROMISE IN THE U.S. AND ITS DEMOCRACTIC PRINCIPLES, BUT BELIEVED THE ABOMINATION OF SLAVERY WOULD BE ITS UNDOING.


WE'RE GOING FROM 1799 THROUGH THE MID-1800S.
AS A YOUNG MAN, ALONG WITH MY SCIENCE COMPANION, AIMÉ BONPLAND, I SPENT FIVE YEARS TRAVERSING SOUTH AMERICA AS WELL AS CUBA AND MEXICO.
IT WAS UP ON THE CHIMBORAZO VOLCANO IN THE ANDES THAT I HAD AN EPIPHANY ABOUT *NATURGEMALDE*— THE UNITY OF NATURE.
I RECOGNIZED THE WEB CONNECTING EVERYTHING ON EARTH. THIS WAS A RADICAL IDEA FOR THE WESTERN WORLD!
I MADE MAPS, SKETCHES, TOOK MEASUREMENTS, THEN PUBLISHED BOOKS ABOUT MY DISCOVERIES WHEN I RETURNED TO EUROPE.
Wild!
BONPLAND AND I SPENT FOUR MONTHS EXPLORING 1,725 MILES OF AMAZON JUNGLE RIVERS. BY SOME **MIRACLE** WE SURVIVED CAPSIZING, CROCODILES, AND JAGUARS! OF COURSE,WE WERE ALSO PLAGUED BY MOSQUITOES, BUT I FOUND THEM WORTHY OF STUDY AND NAMED FIVE NEW SPECIES!
I ALSO NOTED HOW THE CLEARCUTTING OF FORESTS AND DIVERSION OF WATER TO IRRIGATE FARMLAND WAS DAMAGING THE SOIL AND CAUSING CLIMATE CHANGE. I'VE BEEN CALLED THE FOUNDING FATHER OF THE ENVIRONMENTAL MOVEMENT.
What kind of scientist were you?
I WAS A POLYMATH—I STUDIED ***EVERYTHING***. OVER THE FOLLOWING DECADES I PUBLISHED THREE DOZEN BOOKS COVERING TOPICS FROM POLITICS TO PLATE TECTONICS TO BIOLOGY AND EXPLORED THE UNIVERSE IN MY MULTI-VOLUME OPUS, ***COSMOS***.
How did you do all that??
I ONLY SLEPT FOUR HOURS A NIGHT AND I DRANK **MANY** CUPS OF *"CONCENTRATED SUNBEAMS"*— **COFFEE**.
ALSO, I ***NEVER*** MARRIED OR HAD CHILDREN.
I ***PREFERRED*** THE COMPANY OF MEN...
WHICH WAS **DEEPLY** FROWNED UPON BY MY NARROW-MINDED SOCIETY.


SO, THIS IS OUR LAST STOP, 1859. I DIED AT THE AGE OF 89 HERE IN BERLIN, WHERE I WAS BORN.
BY THAT POINT, I WAS ONE OF THE MOST FAMOUS PEOPLE IN THE WORLD.
MY NAME WAS ON STREETS AND TOWNS, THERE WAS A WATER CURRENT NAMED FOR ME, AND STATUES WERE ERECTED TO HONOR MY LEGACY—
BUT THE ACCOLADES DON'T MATTER, IT WAS HAVING MY IDEAS CARRIED ON THAT HAD MEANING TO ME. THE APPRECIATION OF OUR MAGNIFICENT PLANET AND...
I'm sorry, but I never caught your full name—
Bloody hell! Don't they teach anything in schools??
He's the Shakespeare of science— Alexander von Humboldt!
Okay... And, um, whose ghost are you?
Oh, sorry—I didn't recognize you without your full beard...
Mr. Darwin.


CHARLES, TELL OUR FRIEND HERE YOUR BEETLE STORY.
She doesn't want to hear—
I do! Please...
Oh, very well...
Many years ago I was in the forest collecting beetles, when I spied a couple of fine specimens.
I had one in each hand, when I spied a rare third. In order to grab it and not lose the others, I had to hold one of them between my teeth...
I had no sooner nabbed the third, when I felt a terrible, acrid burning in my mouth...
A bombardier beetle can expel a jet of toxic liquid, superheated to the boiling point, as a defense — and it got me in the gob!
Hahahaha great stor—
Mr. Humboldt?
Mr. Darwin?
ANYBODY??
DOWN HERE.


This feels like a horror movie.

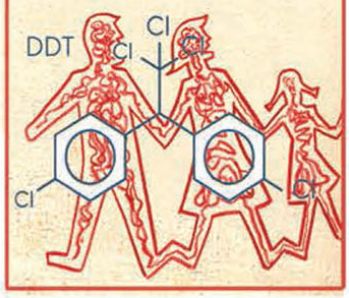
A-Are you... extinct?
I WOULDN'T HAVE PUT IT THAT WAY,
BUT YES, WE'VE BOTH PASSED.
MY NAME'S MARGARET COLLINS. I WAS BORN IN WEST VIRGINIA IN 1922.
THIS IS MY FRIEND, RACHEL CARSON. SHE WAS BORN IN PENNSYLVANIA IN 1907....
SHE'S ALWAYS BEEN A LITTLE BIT SHY.
Why are you here?
WE WOULDN'T MISS THIS INSECT EXHIBITION FOR THE WORLD!
WE BOTH LOVE ARTHROPODS!
RACHEL HERE GREW UP TO BE A MARINE BIOLOGIST AND A BRILLIANT NATURE WRITER.
HER INTEREST LED HER TO WRITE ONE OF THE MOST IMPORTANT BOOKS ON THE ENVIRONMENT EVER WRITTEN...

IN 1958, A FRIEND OF RACHEL'S WROTE HER WITH CONCERNS ABOUT EXCESSIVE, UNAUTHORIZED SPRAYING OF INSECTICIDES ON HER PROPERTY...

THE INSECTICIDE WAS CALLED **DDT**.

THE CHEMICAL INDUSTRY, WITH BACKING FROM THE U.S. DEPARTMENT OF AGRICULTURE, CLAIMED DDT ONLY TARGETED SPECIFIC INSECTS, BUT AS RACHEL BEGAN RESEARCHING, SHE DISCOVERED DDT WAS HAVING A MUCH WIDER IMPACT ACROSS THE ANIMAL KINGDOM...

AND UP THE FOOD CHAIN.



IN 1962, AFTER YEARS OF METICULOUS INVESTIGATION, SHE PUBLISHED A BOOK CALLED ***SILENT SPRING***. IN IT, RACHEL OUTLINED THE RESULTS OF THE INDISCRIMINATE POISONING OF THE NATURAL WORLD BY DDT. SHE DESCRIBED HOW IT COULD LEAD TO A PLANET DEVOID OF THE SOUND OF SONGBIRDS— THE SOUND OF ***ALL*** LIFE.

IT WAS AN INSTANT BESTSELLER AND THE MOST TALKED-ABOUT BOOK IN AMERICA .

SEEING A THREAT TO THEIR $300 MILLION-A-YEAR PROFITS, THE CHEMICAL COMPANIES WENT ON THE ATTACK, CALLING HER HYSTERICAL, A COMMUNIST, AND...

BS

"A fanatical defender of the cult of the balance of nature."

Industry spokesman Dr. Robert White-Stevens

BS

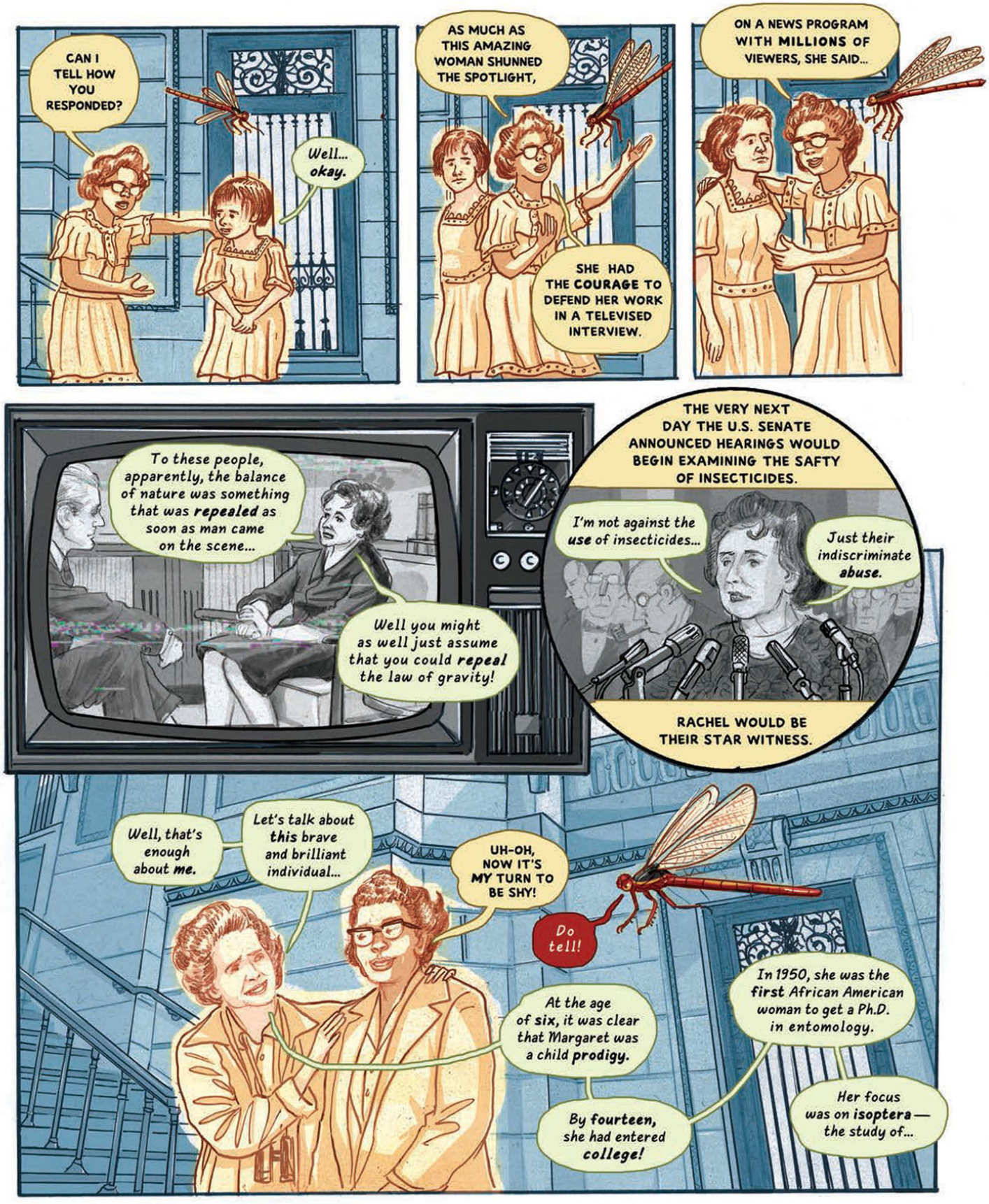
BS

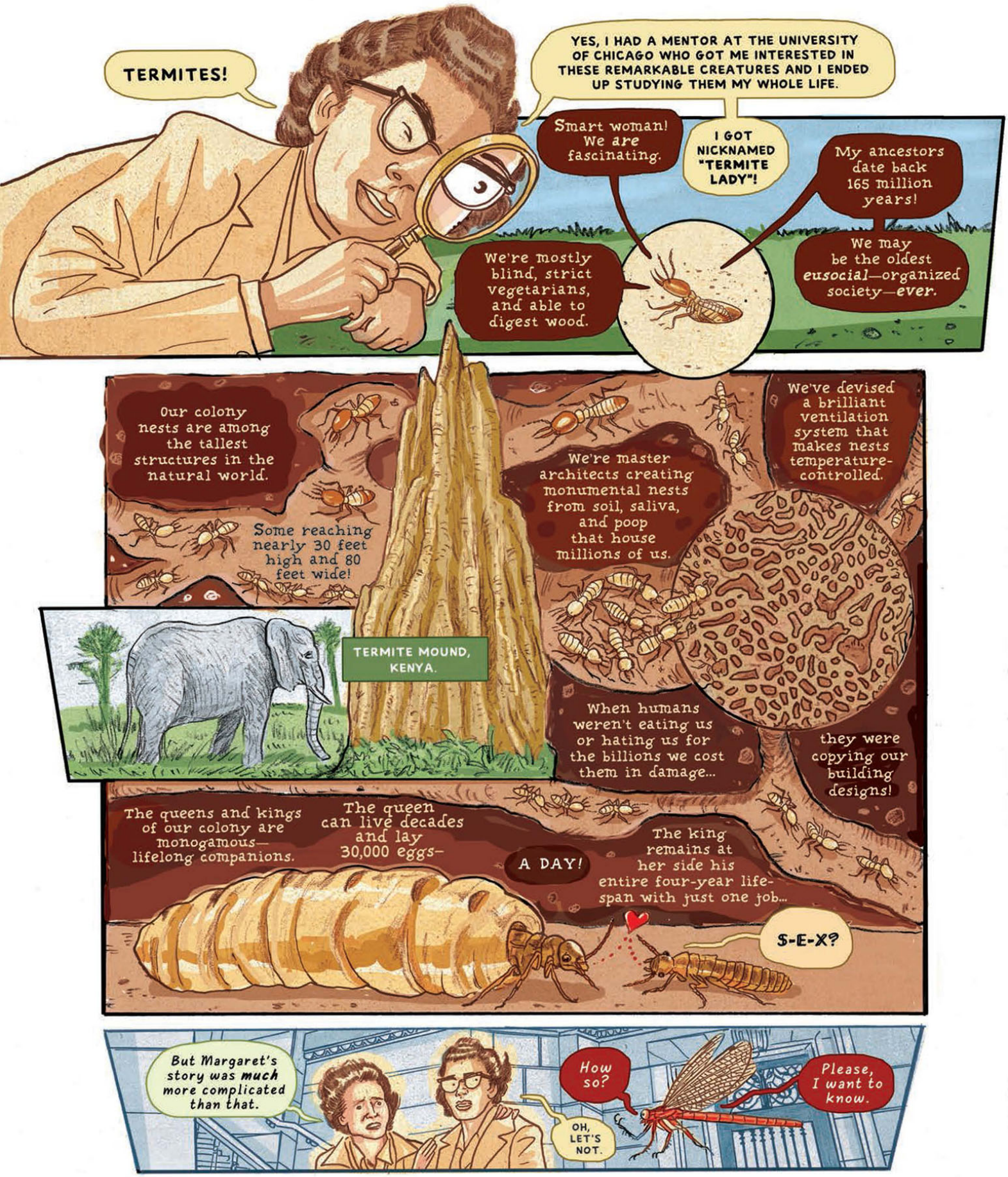
"If man were to follow the teachings of Miss Carson, we would return to the Dark Ages."

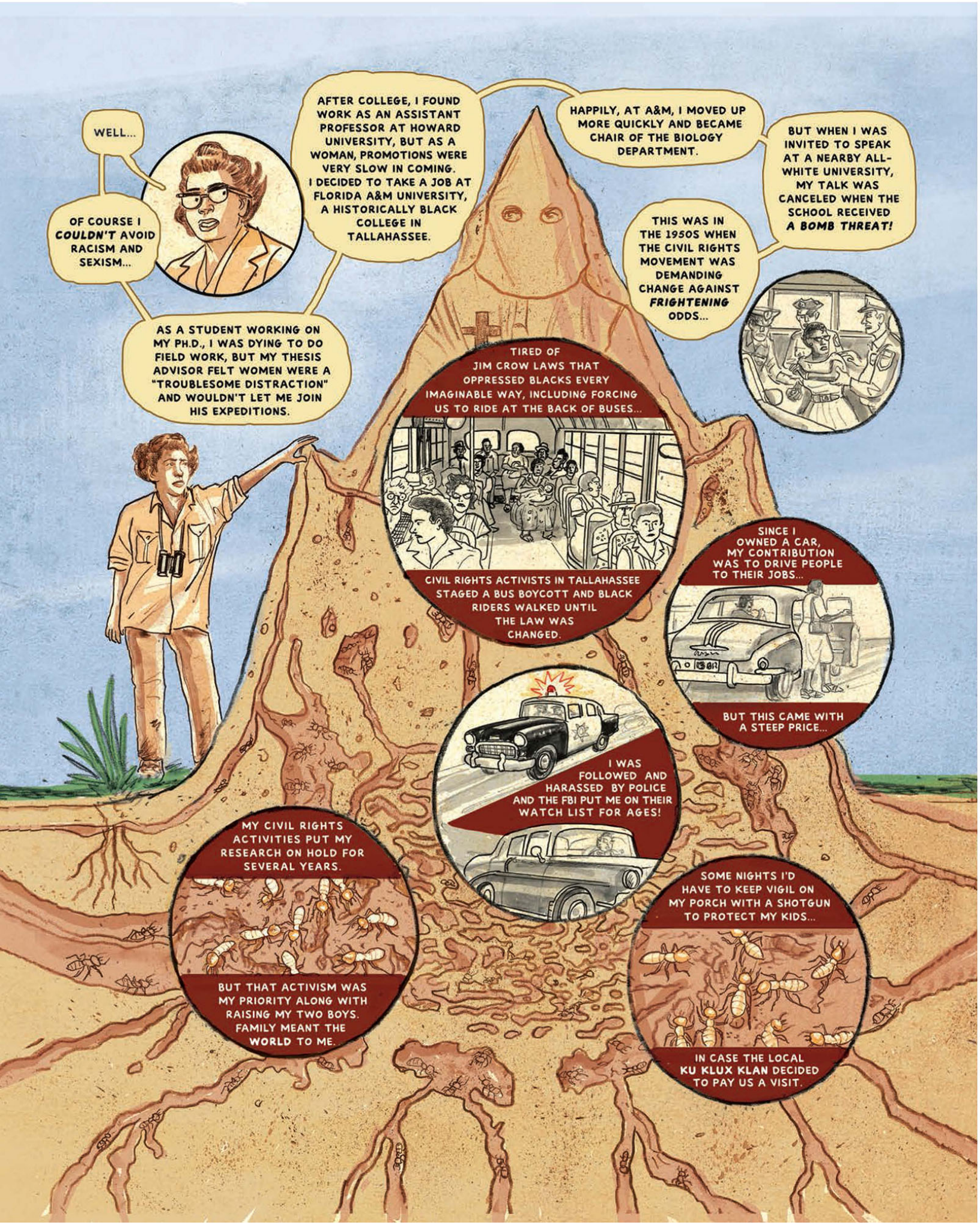
"Miss Carson maintains that the balance of nature is a major force in the survival of man. Whereas the modern scientist believes that man is steadily controlling nature."

AS

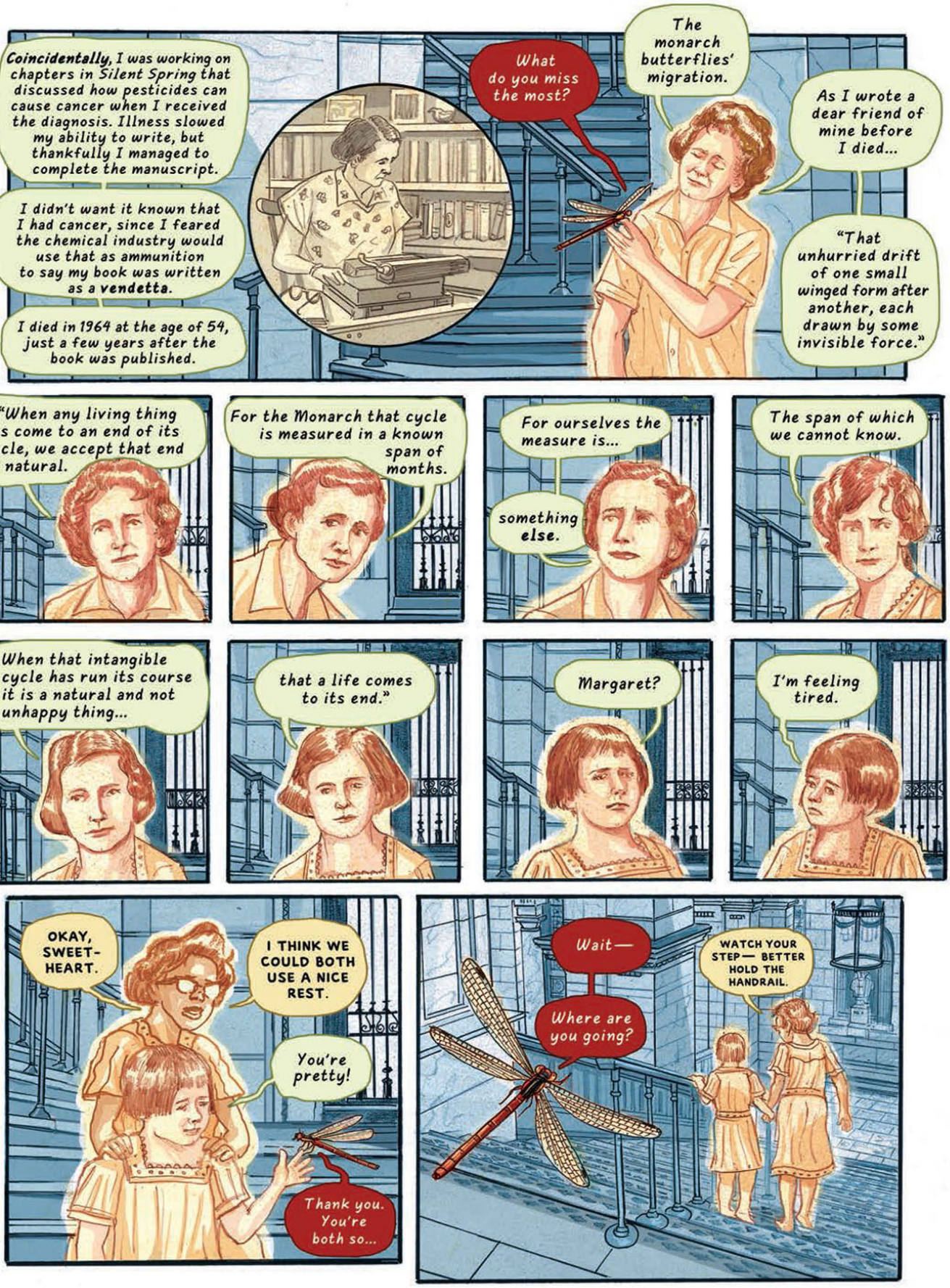
IF

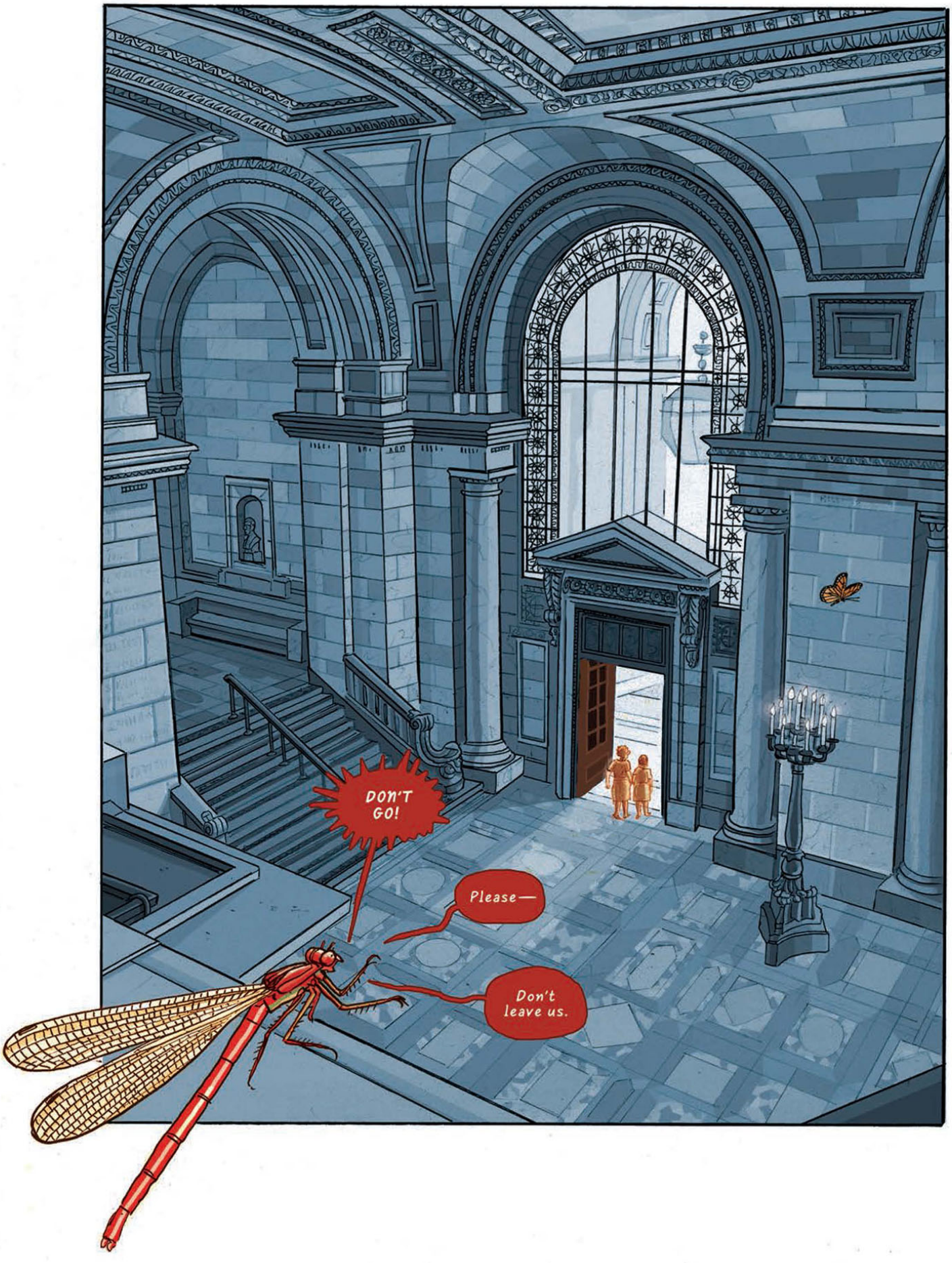

CAN I TELL HOW YOU RESPONDED?
Well... okay.
AS MUCH AS THIS AMAZING WOMAN SHUNNED THE SPOTLIGHT,
SHE HAD THE COURAGE TO DEFEND HER WORK IN A TELEVISED INTERVIEW.
ON A NEWS PROGRAM WITH MILLIONS OF VIEWERS, SHE SAID...
To these people, apparently, the balance of nature was something that was repealed as soon as man came on the scene...
Well you might as well just assume that you could repeal the law of gravity!
THE VERY NEXT DAY THE U.S. SENATE ANNOUNCED HEARINGS WOULD BEGIN EXAMINING THE SAFTY OF INSECTICIDES.
I'm not against the use of insecticides...
Just their indiscriminate abuse.
RACHEL WOULD BE THEIR STAR WITNESS.
Well, that's enough about me.
Let's talk about this brave and brilliant individual...
UH-OH, NOW IT'S MY TURN TO BE SHY!
Do tell!
At the age of six, it was clear that Margaret was a child prodigy.
By fourteen, she had entered college!
In 1950, she was the first African American woman to get a Ph.D. in entomology.
Her focus was on isoptera — the study of...


TERMITES!
YES, I HAD A MENTOR AT THE UNIVERSITY OF CHICAGO WHO GOT ME INTERESTED IN THESE REMARKABLE CREATURES AND I ENDED UP STUDYING THEM MY WHOLE LIFE.
Smart woman! We are fascinating.
I GOT NICKNAMED "TERMITE LADY"!
My ancestors date back 165 million years!
We're mostly blind, strict vegetarians, and able to digest wood.
We may be the oldest eusocial—organized society—ever.
Our colony nests are among the tallest structures in the natural world.
Some reaching nearly 30 feet high and 80 feet wide!
TERMITE MOUND, KENYA.
We're master architects creating monumental nests from soil, saliva, and poop that house millions of us.
We've devised a brilliant ventilation system that makes nests temperature-controlled.
When humans weren't eating us or hating us for the billions we cost them in damage...
they were copying our building designs!
The queens and kings of our colony are monogamous—lifelong companions.
The queen can live decades and lay 30,000 eggs—
A DAY!
The king remains at her side his entire four-year life-span with just one job...
S-E-X?
But Margaret's story was much more complicated than that.
How so?
OH, LET'S NOT.
Please, I want to know.


WELL...
OF COURSE I COULDN'T AVOID RACISM AND SEXISM...
AFTER COLLEGE, I FOUND WORK AS AN ASSISTANT PROFESSOR AT HOWARD UNIVERSITY, BUT AS A WOMAN, PROMOTIONS WERE VERY SLOW IN COMING. I DECIDED TO TAKE A JOB AT FLORIDA A&M UNIVERSITY, A HISTORICALLY BLACK COLLEGE IN TALLAHASSEE.
AS A STUDENT WORKING ON MY PH.D., I WAS DYING TO DO FIELD WORK, BUT MY THESIS ADVISOR FELT WOMEN WERE A "TROUBLESOME DISTRACTION" AND WOULDN'T LET ME JOIN HIS EXPEDITIONS.
HAPPILY, AT A&M, I MOVED UP MORE QUICKLY AND BECAME CHAIR OF THE BIOLOGY DEPARTMENT.
BUT WHEN I WAS INVITED TO SPEAK AT A NEARBY ALL-WHITE UNIVERSITY, MY TALK WAS CANCELED WHEN THE SCHOOL RECEIVED A BOMB THREAT!
THIS WAS IN THE 1950S WHEN THE CIVIL RIGHTS MOVEMENT WAS DEMANDING CHANGE AGAINST FRIGHTENING ODDS...
TIRED OF JIM CROW LAWS THAT OPPRESSED BLACKS EVERY IMAGINABLE WAY, INCLUDING FORCING US TO RIDE AT THE BACK OF BUSES...
CIVIL RIGHTS ACTIVISTS IN TALLAHASSEE STAGED A BUS BOYCOTT AND BLACK RIDERS WALKED UNTIL THE LAW WAS CHANGED.
SINCE I OWNED A CAR, MY CONTRIBUTION WAS TO DRIVE PEOPLE TO THEIR JOBS...
BUT THIS CAME WITH A STEEP PRICE...
I WAS FOLLOWED AND HARASSED BY POLICE AND THE FBI PUT ME ON THEIR WATCH LIST FOR AGES!
MY CIVIL RIGHTS ACTIVITIES PUT MY RESEARCH ON HOLD FOR SEVERAL YEARS.
BUT THAT ACTIVISM WAS MY PRIORITY ALONG WITH RAISING MY TWO BOYS. FAMILY MEANT THE WORLD TO ME.
SOME NIGHTS I'D HAVE TO KEEP VIGIL ON MY PORCH WITH A SHOTGUN TO PROTECT MY KIDS...
IN CASE THE LOCAL KU KLUX KLAN DECIDED TO PAY US A VISIT.

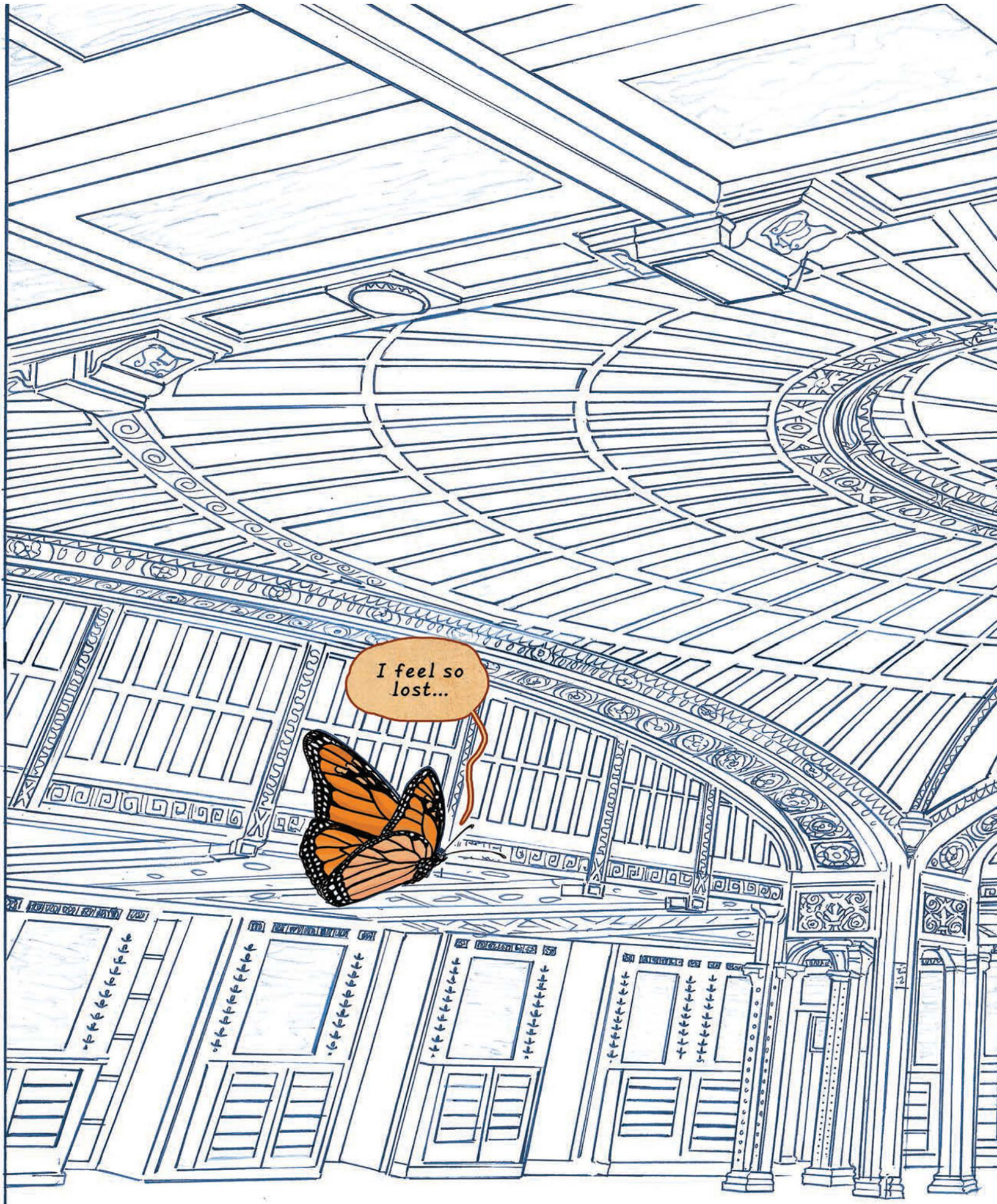
IN MANY WAYS MY LOVE OF INSECTS HELPED ME TRIUMPH OVER THE NUMEROUS CHALLENGES I FACED.
MY PASSION FOR STUDYING TERMITES LED TO POSITIONS AT VARIOUS UNIVERSITIES, THE PRESIDENCY OF THE ENTOMOLOGICAL SOCIETY...
AND IN MY FINAL DECADES, A RESEARCH JOB AT THE SMITHSONIAN NATIONAL MUSEUM OF NATURAL HISTORY IN WASHINGTON, D.C.
THIS ALLOWED ME TO DO MY BELOVED FIELD WORK TO THE END.
The Bahamas
Cuba
Cayman Islands
Jamaica
Caribbean Sea
IN FACT, I DIED ON AN EXPEDITION RESEARCHING TERMITES IN THE CAYMAN ISLANDS AT THE AGE OF 73.
We will miss you, Termite Lady.
DEAR RACHEL WAS NOT AS FORTUNATE.
Why— what happened??
I... I got sick...
With cancer.

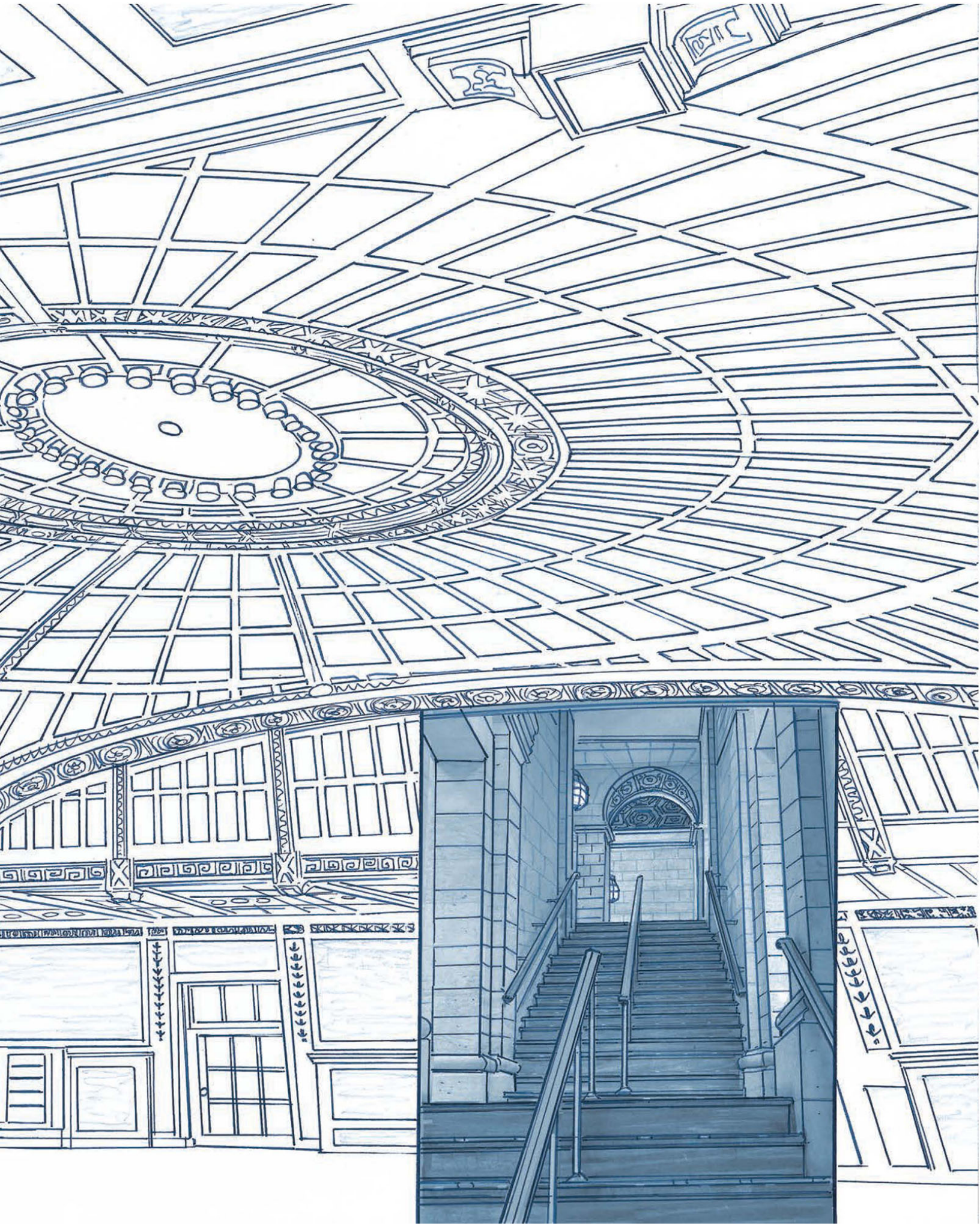

Coincidentally, I was working on chapters in Silent Spring that discussed how pesticides can cause cancer when I received the diagnosis. Illness slowed my ability to write, but thankfully I managed to complete the manuscript.
I didn't want it known that I had cancer, since I feared the chemical industry would use that as ammunition to say my book was written as a vendetta.
I died in 1964 at the age of 54, just a few years after the book was published.
What do you miss the most?
The monarch butterflies' migration.
As I wrote a dear friend of mine before I died...
"That unhurried drift of one small winged form after another, each drawn by some invisible force."
"When any living thing has come to an end of its cycle, we accept that end as natural.
For the Monarch that cycle is measured in a known span of months.
For ourselves the measure is...
something else.
The span of which we cannot know.
When that intangible cycle has run its course it is a natural and not unhappy thing...
that a life comes to its end."
Margaret?
I'm feeling tired.
OKAY, SWEETHEART.
I THINK WE COULD BOTH USE A NICE REST.
You're pretty!
Thank you. You're both so...
Wait—
Where are you going?
WATCH YOUR STEP— BETTER HOLD THE HANDRAIL.

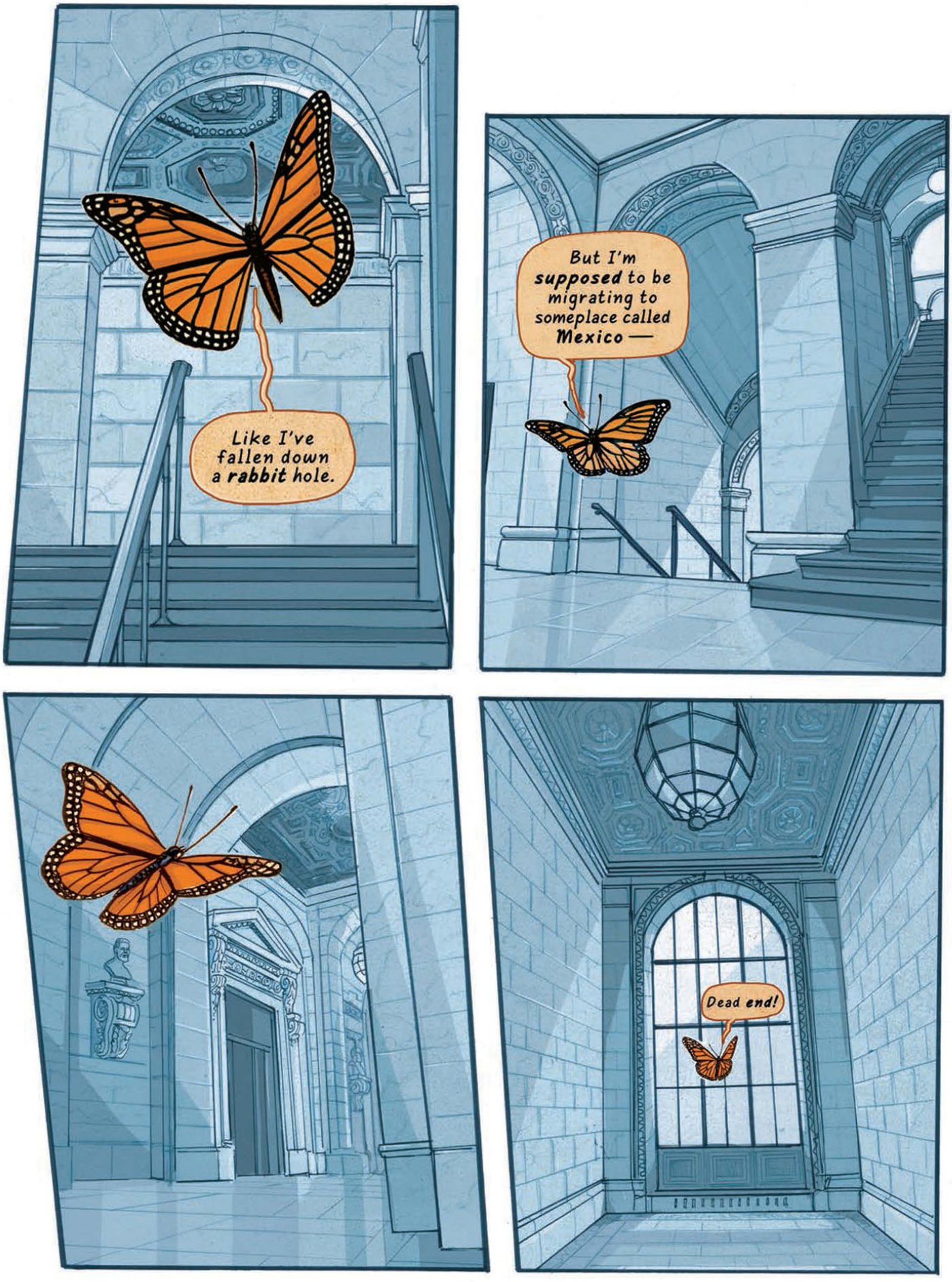

DON'T GO!
Please—
Don't leave us.

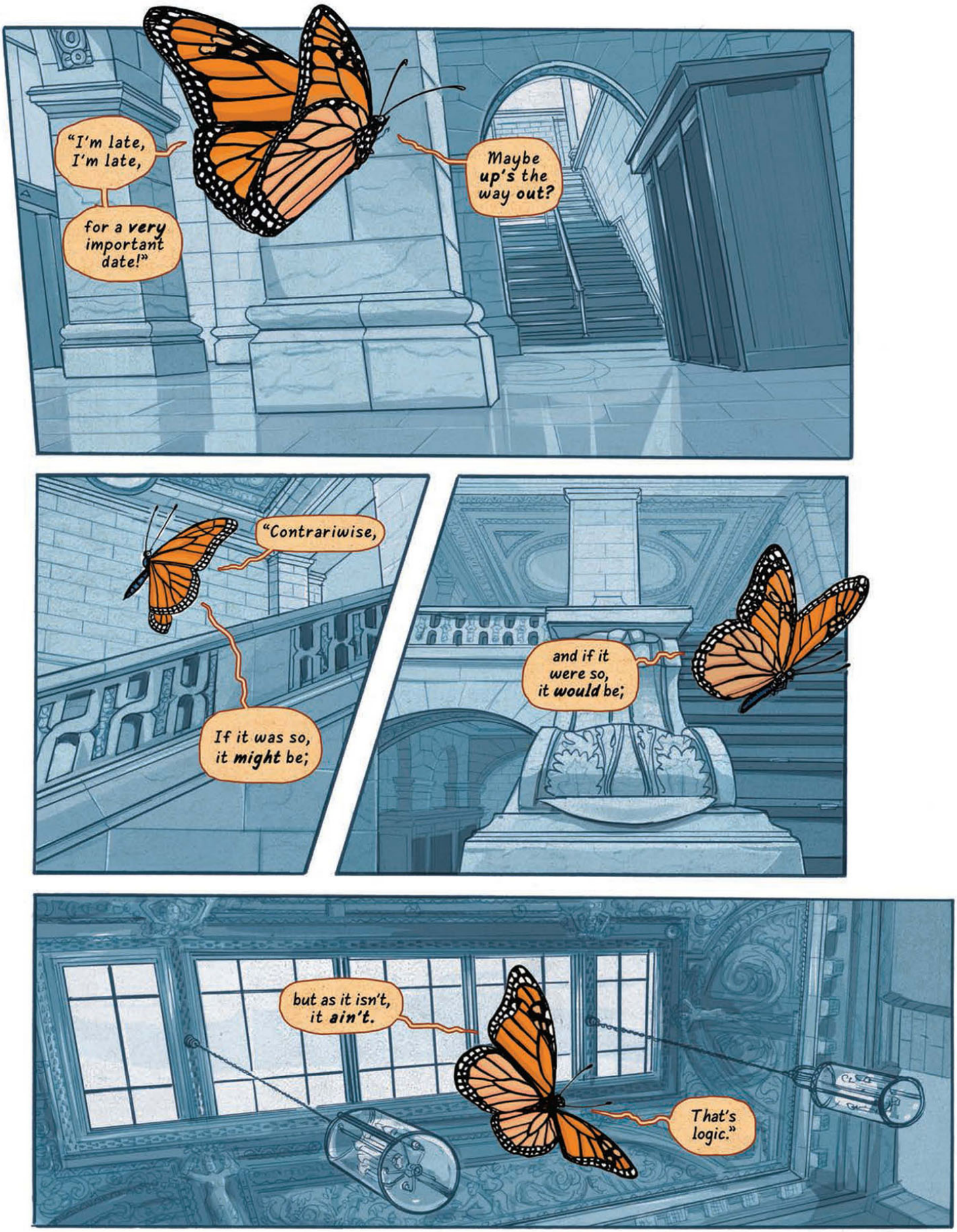
Advice from a Caterpillar

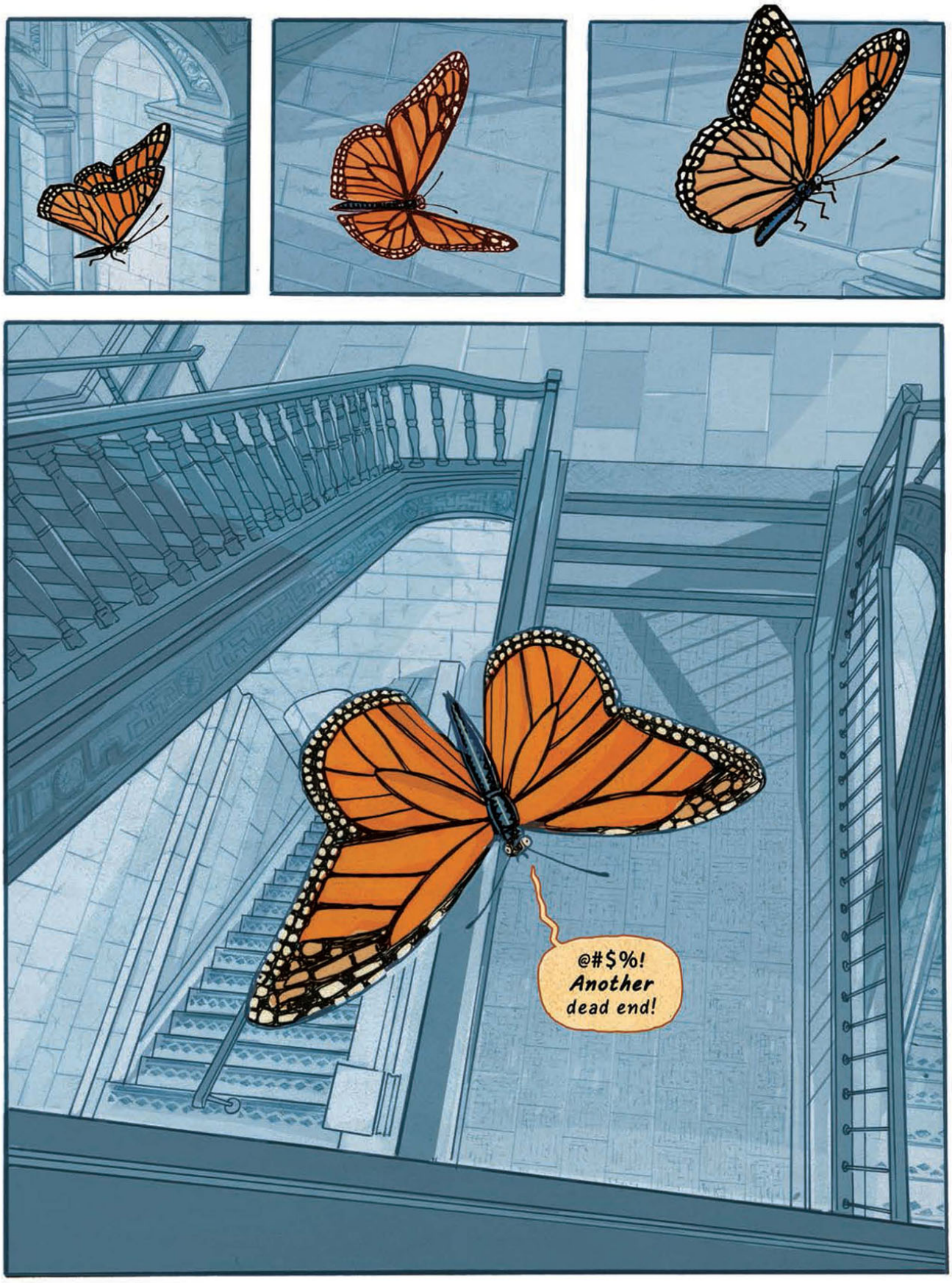
Charles Lutwidge Dodgson
under the pen name Lewis Carroll
(1832-1898)
Alice's Adventures in Wonderland
Published in 1865
with illustrations by John Tenniel

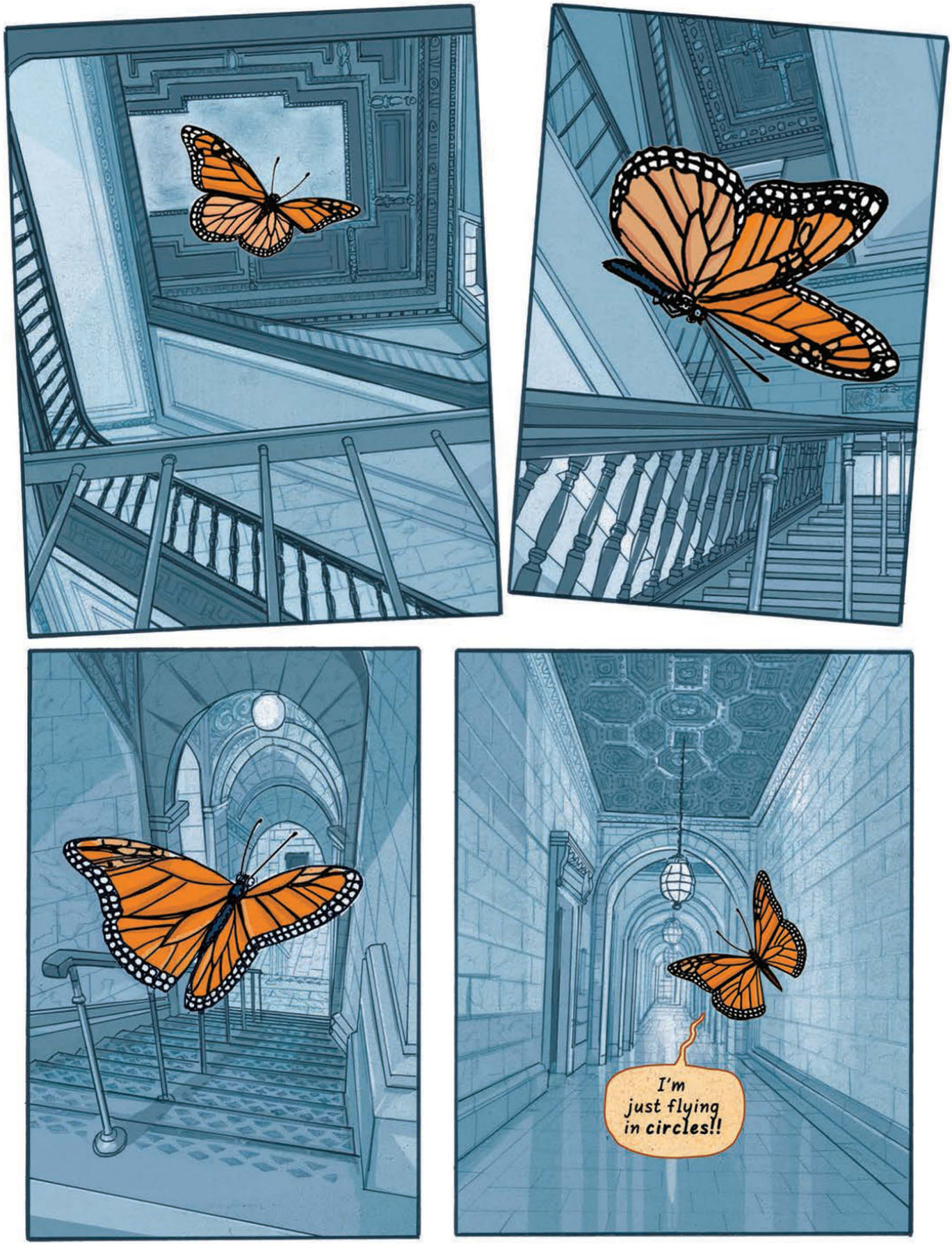

I feel so lost...

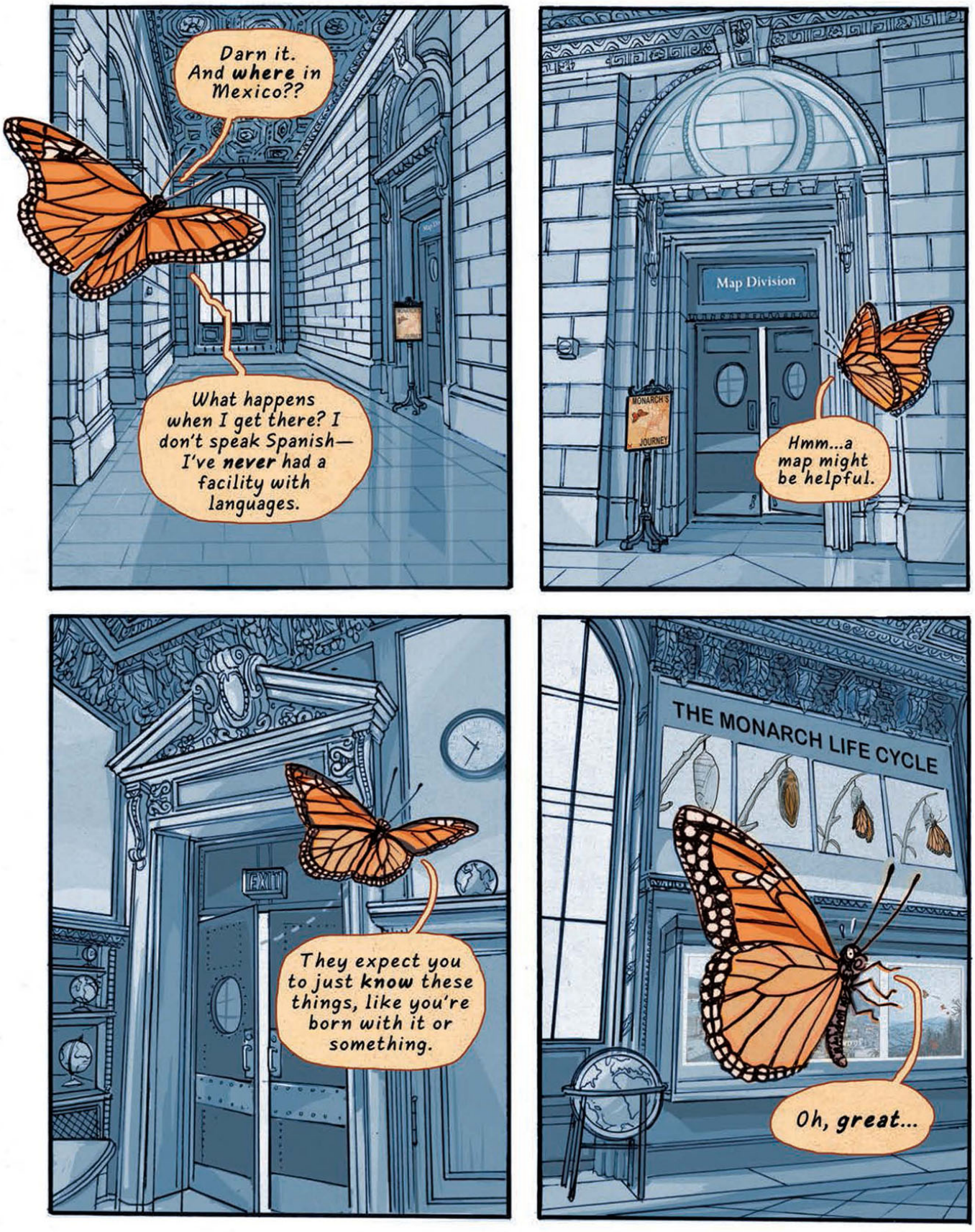



Like I've fallen down a rabbit hole.
But I'm supposed to be migrating to someplace called Mexico —
Dead end!

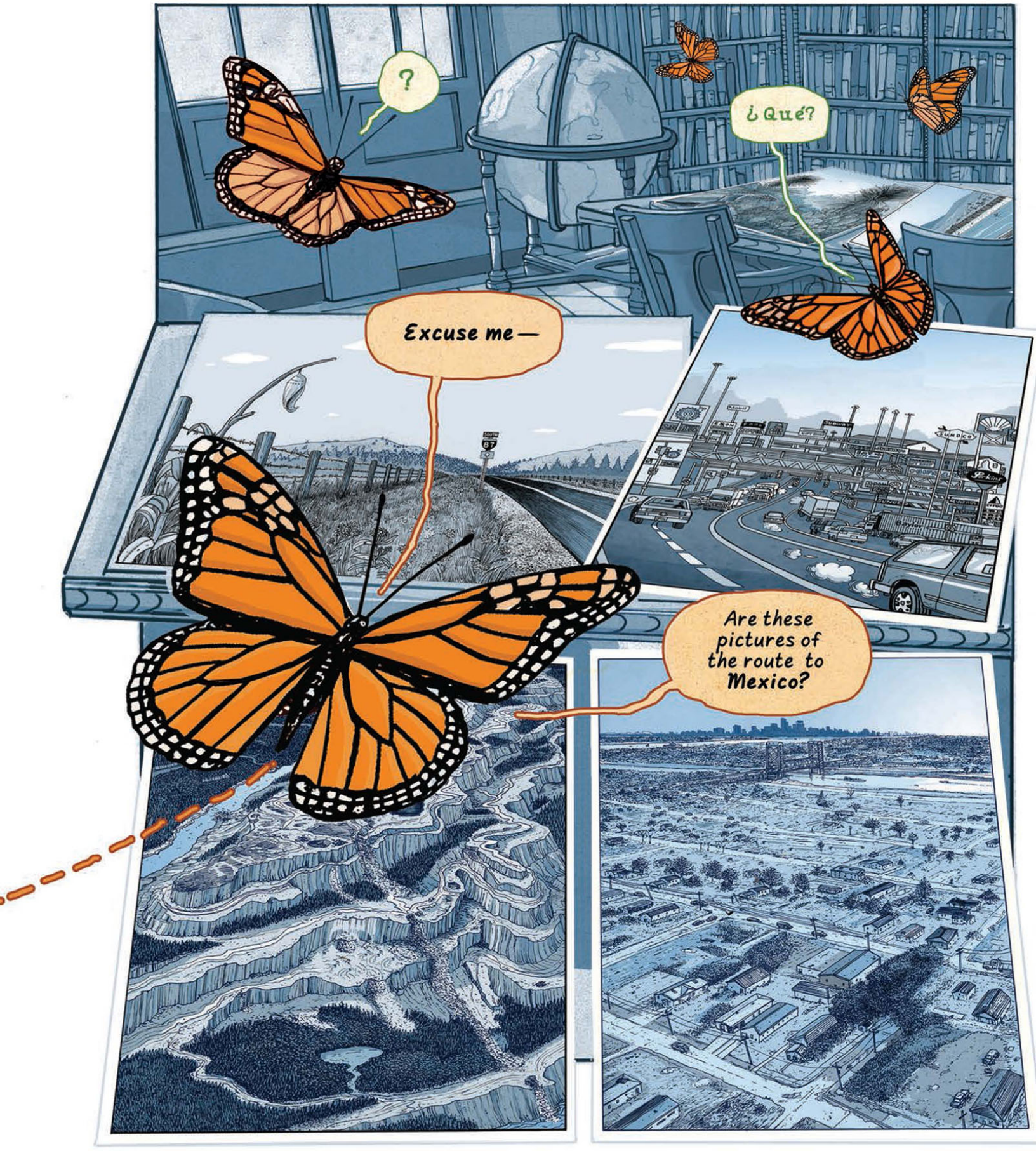

"I'm late, I'm late,
for a very important date!"
Maybe up's the way out?
"Contrariwise,
If it was so, it might be;
and if it were so, it would be;
but as it isn't, it ain't.
That's logic."


@#$%!
Another
dead end!

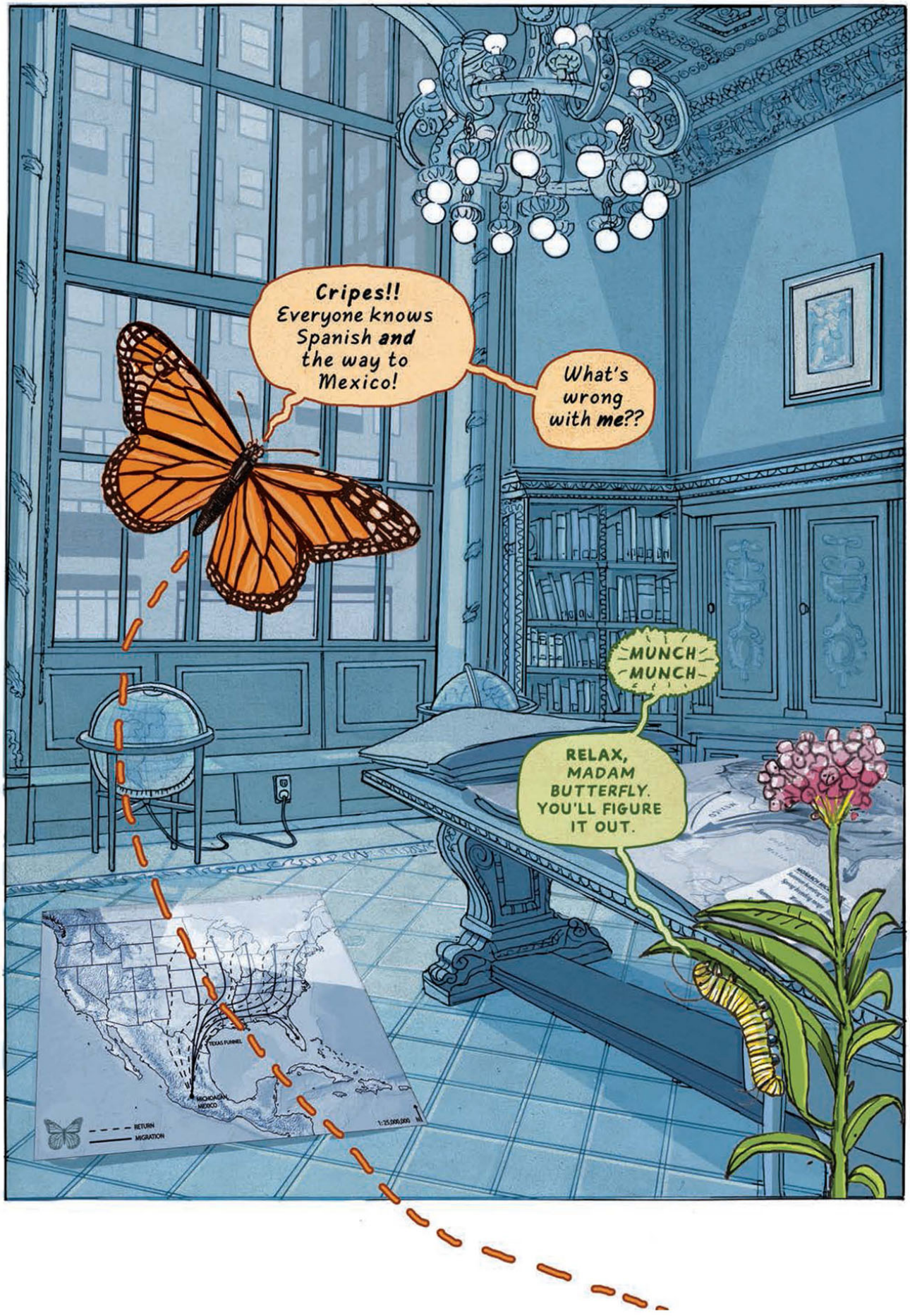

I'm just flying in circles!!

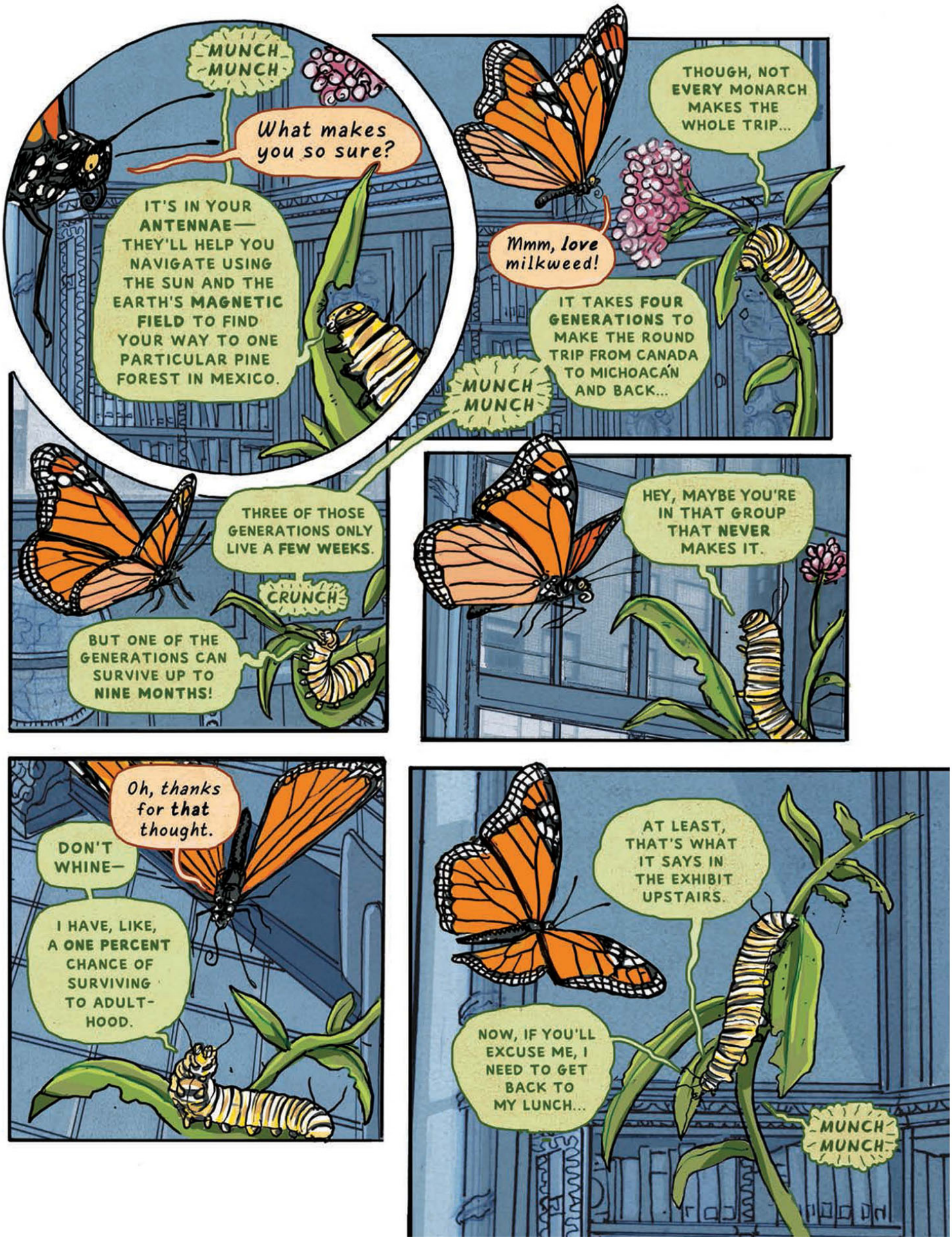

Darn it. And **where** in Mexico??
What happens when I get there? I don't speak Spanish—I've **never** had a facility with languages.
Map Division
MONARCH'S JOURNEY
Hmm...a map might be helpful.
EXIT
They expect you to just **know** these things, like you're born with it or something.
THE MONARCH LIFE CYCLE
Oh, **great**...

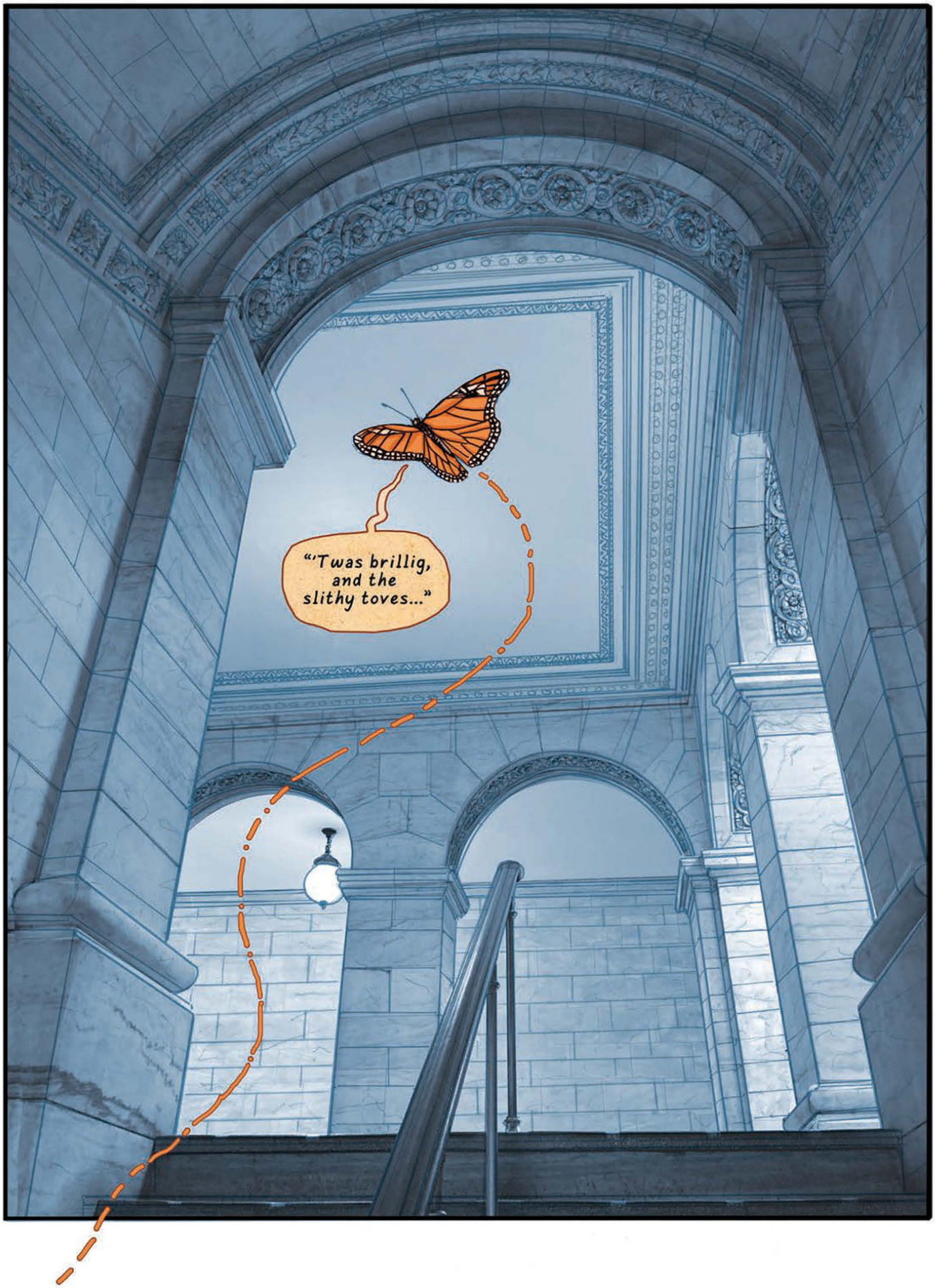
¿Qué es eso?
Son dibujos.
¡De nuestro viaje a México!

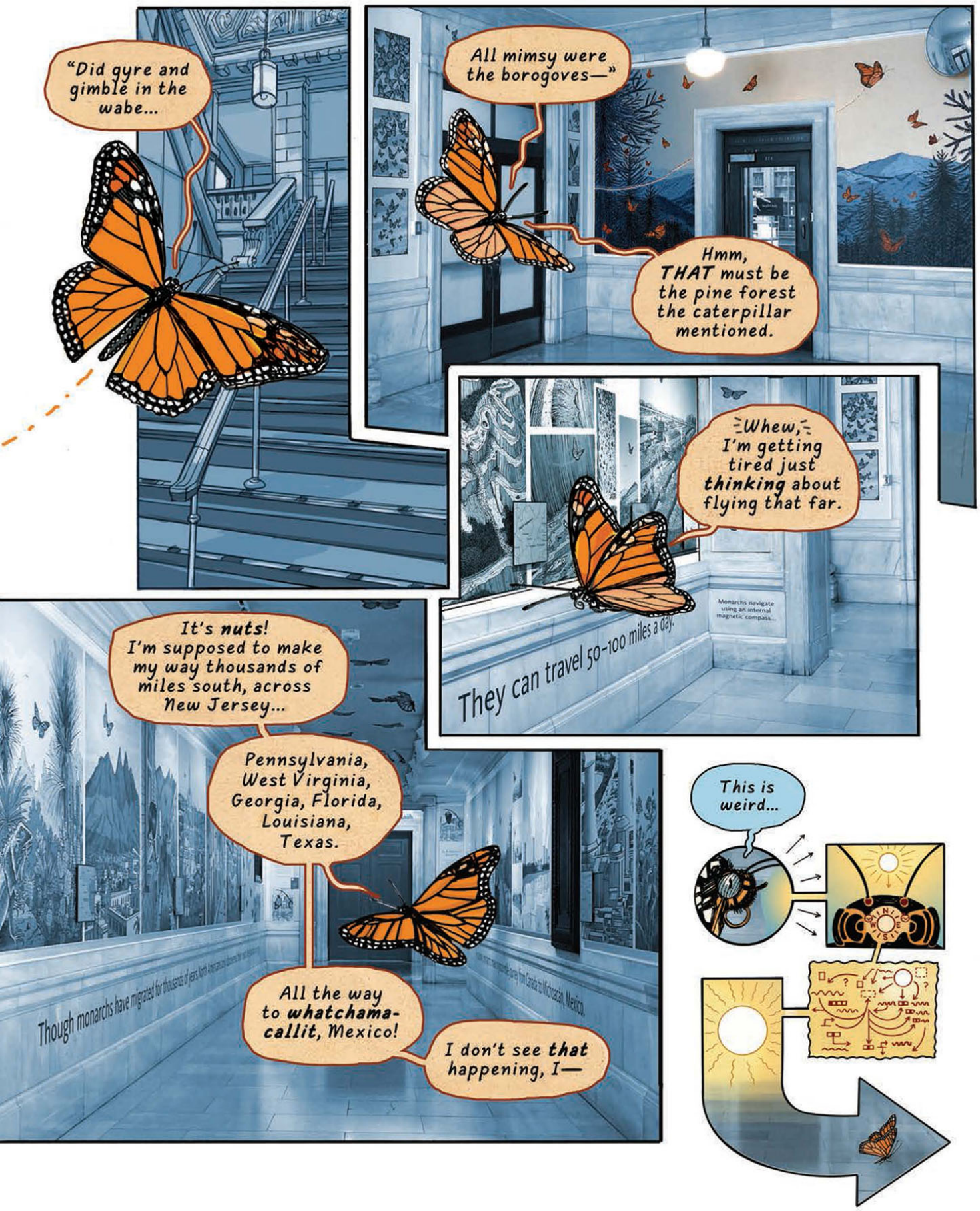

?
¿Qué?
Excuse me—
Are these pictures of the route to Mexico?

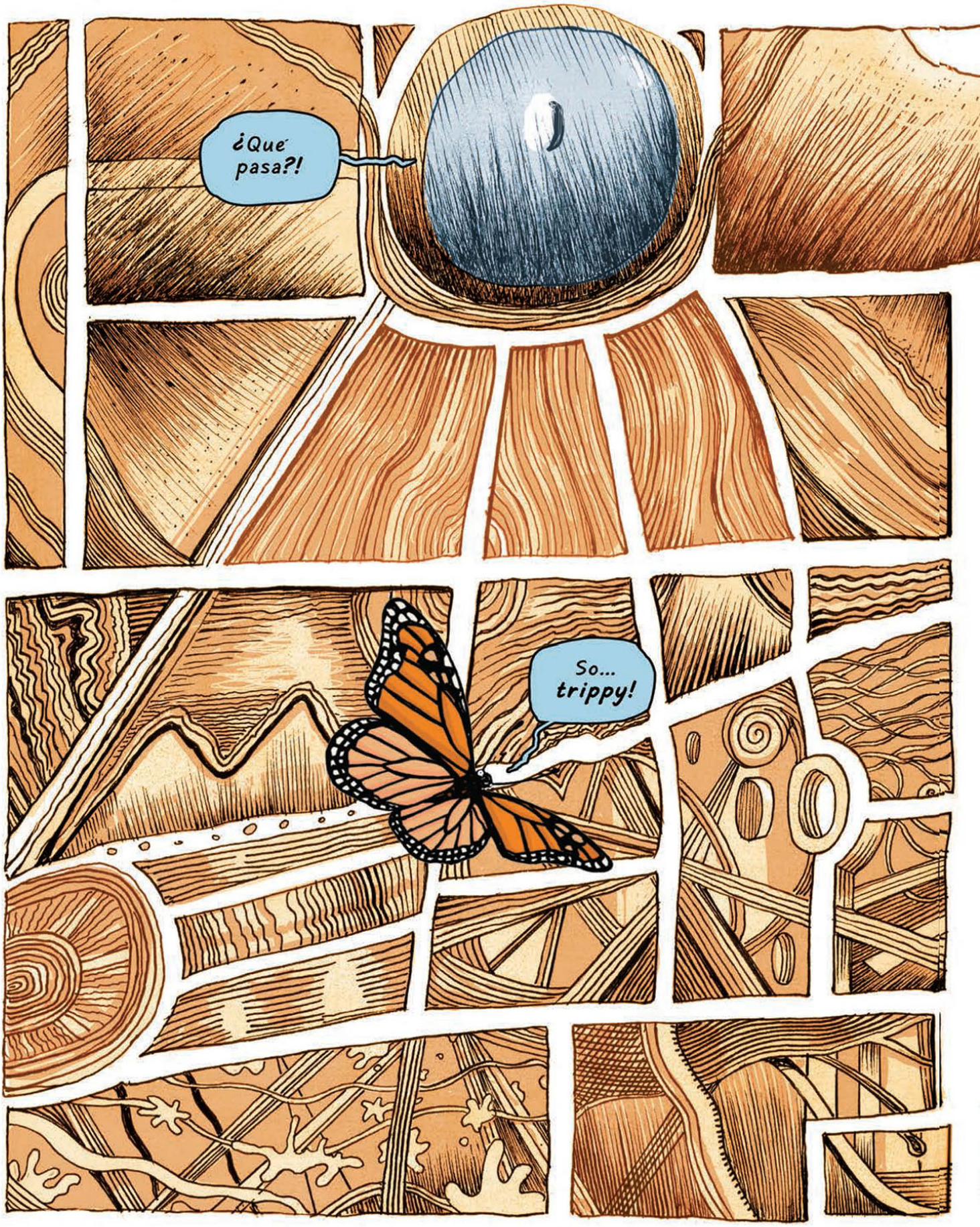
¿México?
¿No hablas Español?

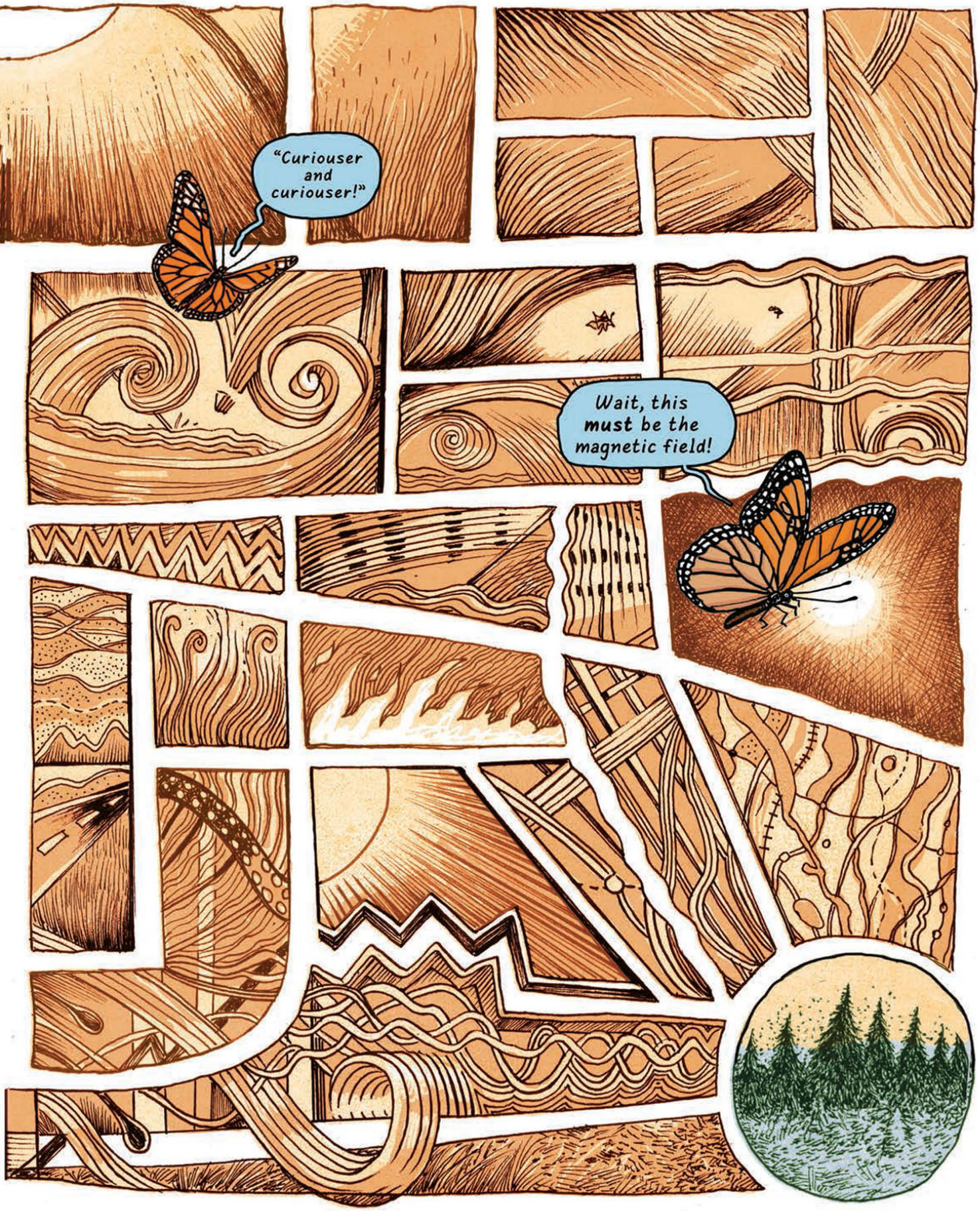

Cripes!! Everyone knows Spanish and the way to Mexico!
What's wrong with me??
MUNCH MUNCH
RELAX, MADAM BUTTERFLY. YOU'LL FIGURE IT OUT.
TEXAS FUNNEL
MICHOACAN, MEXICO
RETURN MIGRATION
1:25,000,000

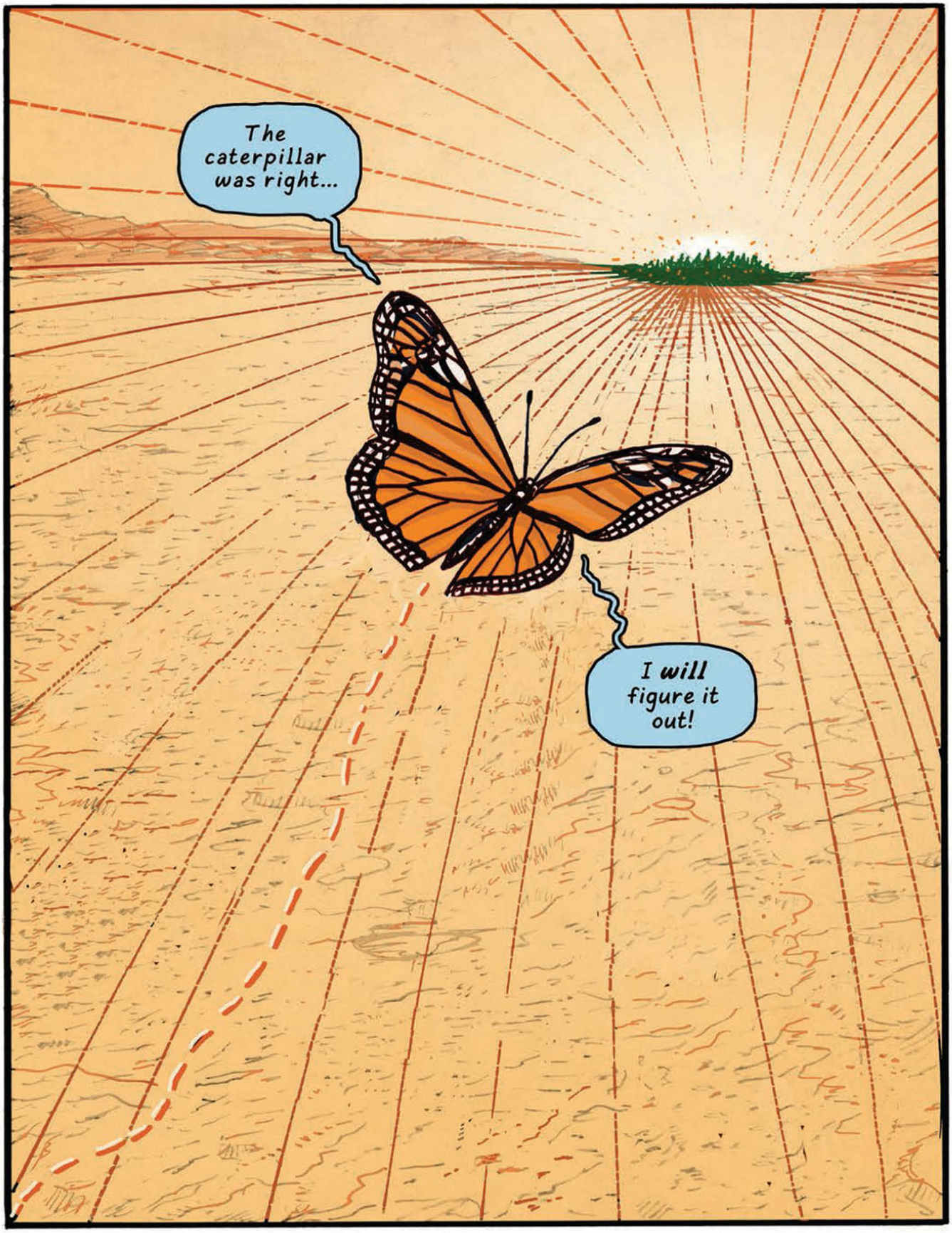

MUNCH MUNCH
What makes you so sure?
IT'S IN YOUR ANTENNAE— THEY'LL HELP YOU NAVIGATE USING THE SUN AND THE EARTH'S MAGNETIC FIELD TO FIND YOUR WAY TO ONE PARTICULAR PINE FOREST IN MEXICO.
THOUGH, NOT EVERY MONARCH MAKES THE WHOLE TRIP...
Mmm, love milkweed!
IT TAKES FOUR GENERATIONS TO MAKE THE ROUND TRIP FROM CANADA TO MICHOACÁN AND BACK...
MUNCH MUNCH
THREE OF THOSE GENERATIONS ONLY LIVE A FEW WEEKS.
CRUNCH
BUT ONE OF THE GENERATIONS CAN SURVIVE UP TO NINE MONTHS!
HEY, MAYBE YOU'RE IN THAT GROUP THAT NEVER MAKES IT.
Oh, thanks for that thought.
DON'T WHINE—
I HAVE, LIKE, A ONE PERCENT CHANCE OF SURVIVING TO ADULT-HOOD.
AT LEAST, THAT'S WHAT IT SAYS IN THE EXHIBIT UPSTAIRS.
NOW, IF YOU'LL EXCUSE ME, I NEED TO GET BACK TO MY LUNCH...
MUNCH MUNCH


"'Twas brillig, and the slithy toves..."


"Did gyre and gimble in the wabe...
All mimsy were the borogoves—"
Hmm, THAT must be the pine forest the caterpillar mentioned.
Whew, I'm getting tired just thinking about flying that far.
Monarchs navigate using an internal magnetic compass...
They can travel 50-100 miles a day.
It's nuts! I'm supposed to make my way thousands of miles south, across New Jersey...
Pennsylvania, West Virginia, Georgia, Florida, Louisiana, Texas.
All the way to whatchama-callit, Mexico!
I don't see that happening, I—
Though monarchs have migrated for thousands of years from Canada to Michoacán, Mexico.
This is weird...


¿Que pasa?!
So... trippy!

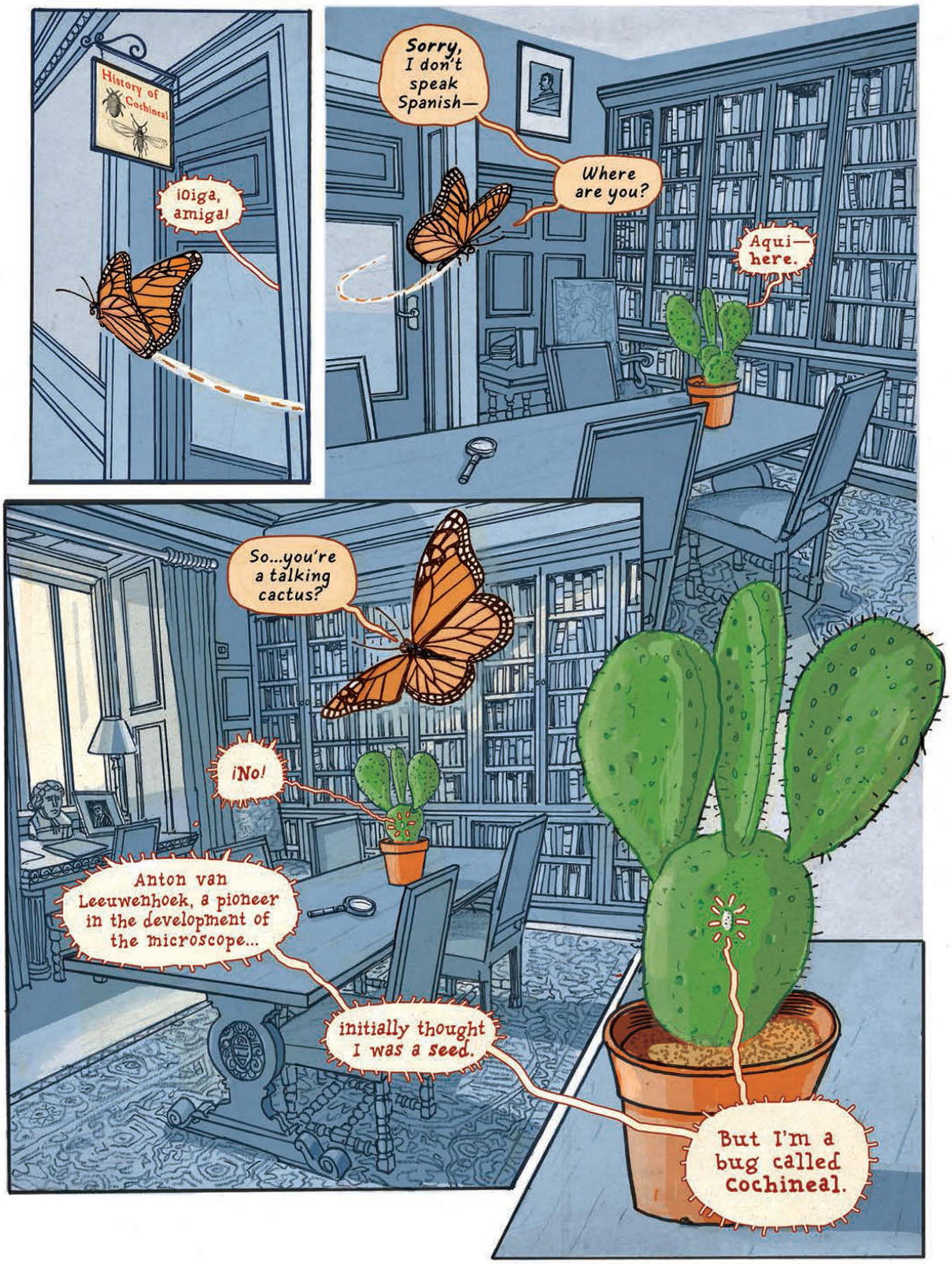

"Curiouser and curiouser!"
Wait, this **must** be the magnetic field!

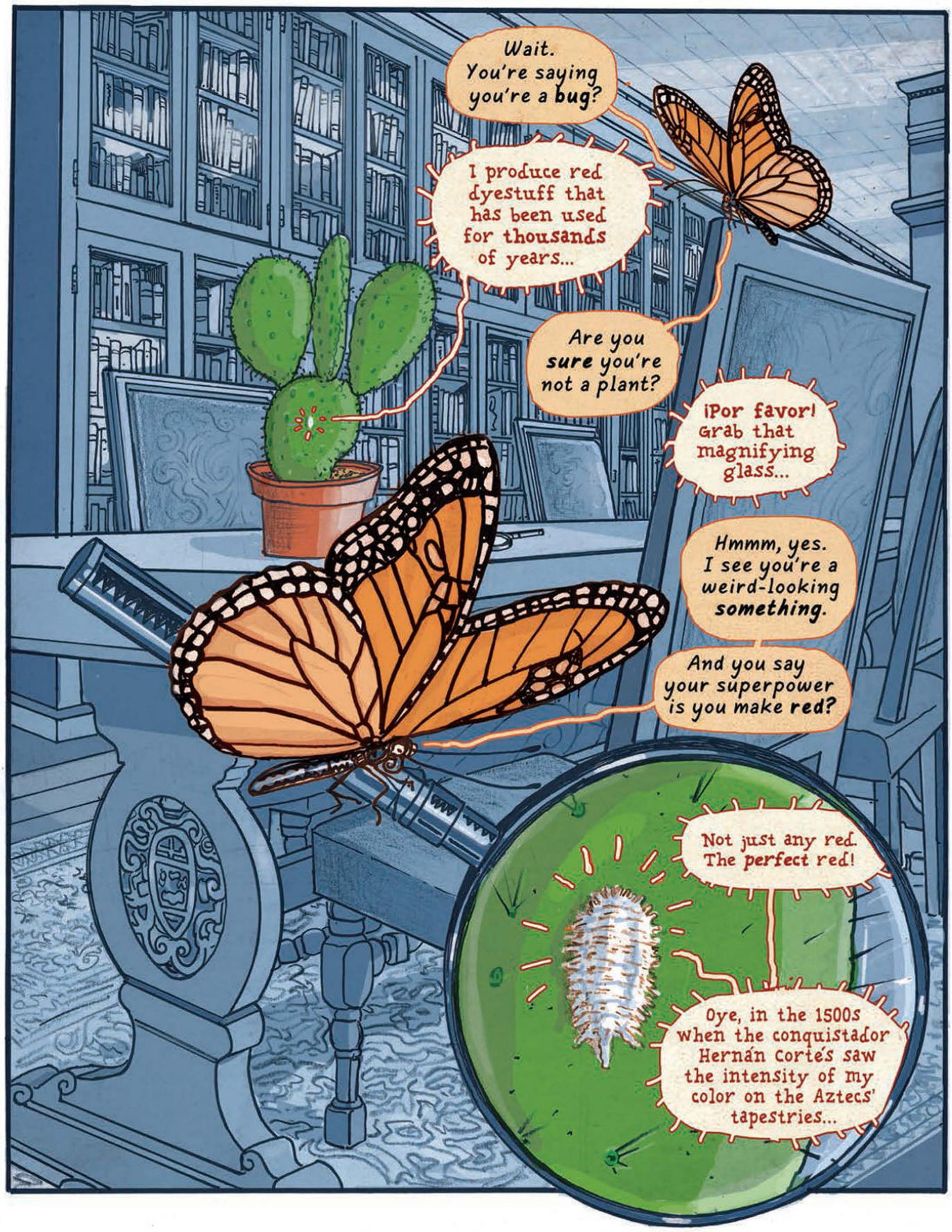

The caterpillar was right...
I will figure it out!

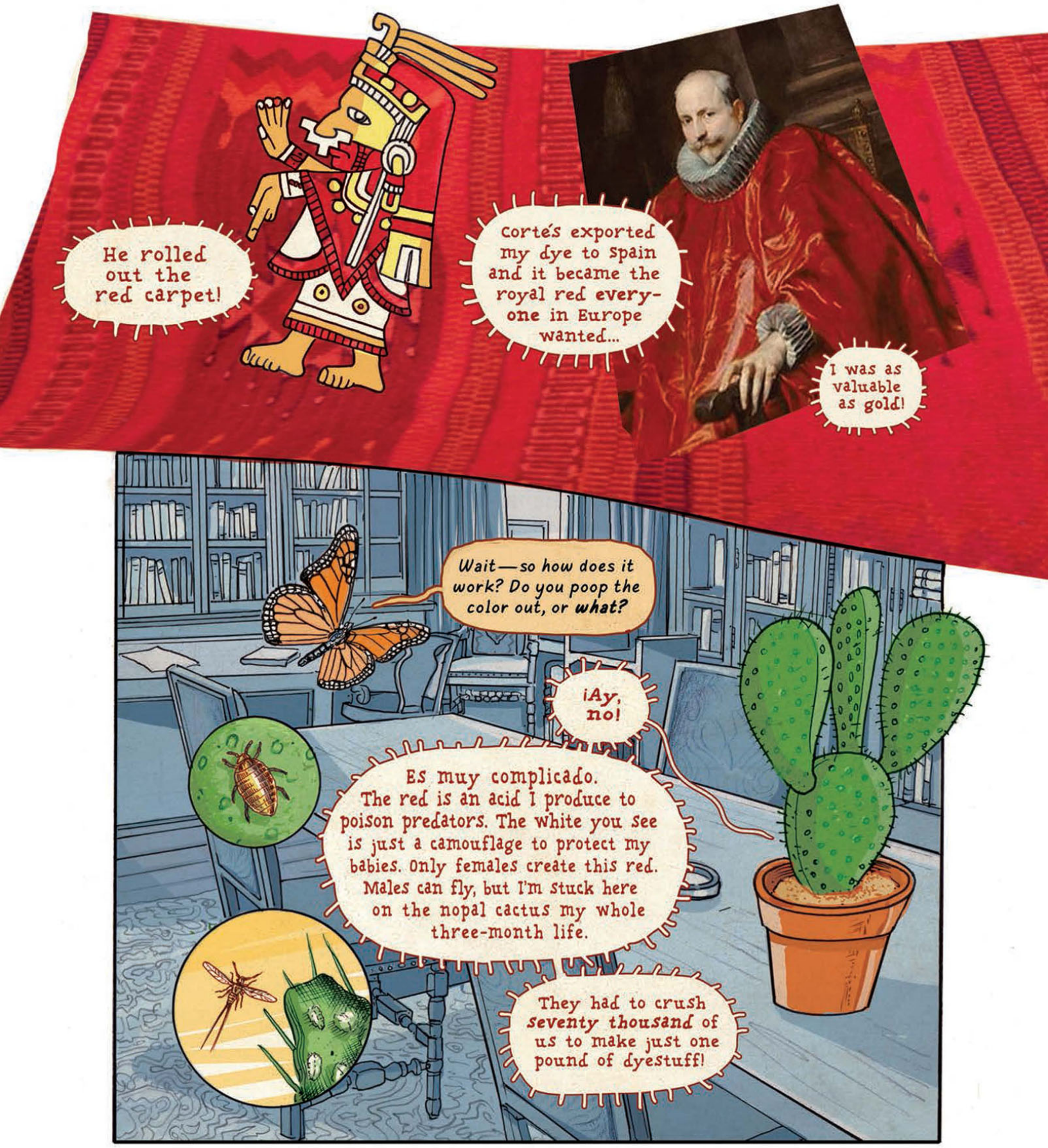
To a Monarch Butterfly
Homero Aridjis
A Una Mariposa Monarca
Homero Aridjis
Now all I have to do...

is find the exit...
A Una Mariposa Monarca
Tu que vas por el día
Como un tigre alado
Quemándote en tu vuelo
Dime qué vida sobrenatural
Está pintada en tus alas
Para que despues de esta vida
Pueda verte en mi noche
—Homero Aridjis (b. 1940)
and learn Spanish!
TRANSLATED BY GEORGE MCWHIRTER

"Oh frabjous day!
Callooh! Callay!"


History of Cochineal
¡Oiga, amiga!
Sorry, I don't speak Spanish—
Where are you?
Aqui—here.
So...you're a talking cactus?
¡No!
Anton van Leeuwenhoek, a pioneer in the development of the microscope...
initially thought I was a seed.
But I'm a bug called cochineal.

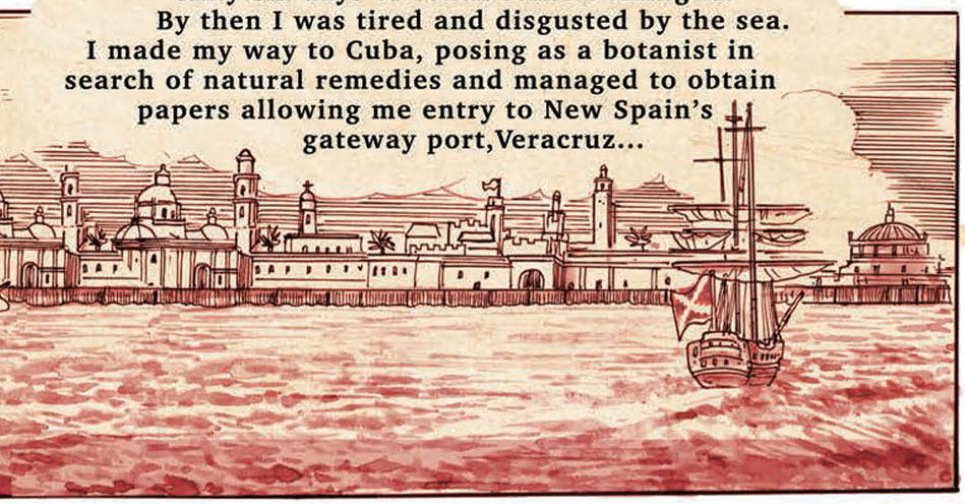

Wait. You're saying you're a bug?
I produce red dyestuff that has been used for thousands of years...
Are you sure you're not a plant?
¡Por favor! Grab that magnifying glass...
Hmmm, yes. I see you're a weird-looking something.
And you say your superpower is you make red?
Not just any red. The perfect red!
Oye, in the 1500s when the conquistador Hernán Cortés saw the intensity of my color on the Aztecs' tapestries...


He rolled out the red carpet!
Cortés exported my dye to Spain and it became the royal red everyone in Europe wanted...
I was as valuable as gold!
Wait—so how does it work? Do you poop the color out, or *what?*
¡Ay, no!
Es muy complicado. The red is an acid I produce to poison predators. The white you see is just a camouflage to protect my babies. Only females create this red. Males can fly, but I'm stuck here on the nopal cactus my whole three-month life.
They had to crush *seventy thousand* of us to make just one pound of dyestuff!

Los norteamericanos wanted us for the red stripes on their flag...
The British officers wanted us for their fancy Red Coats.
And artistas from Vermeer to Van Gogh wanted us for their paints.
Wow. Okay, I'm impressed. A tiny thing like you being worth a fortune!
Oh sí—Dutch, Italians, English, the whole world wanted a piece of me...
Yet the Spanish managed to keep us their little secret for nearly three centuries!
A bio-pirate almost succeeded in smuggling us out of Mexico—what they called "New Spain." It would have been one of the greatest heists in history!

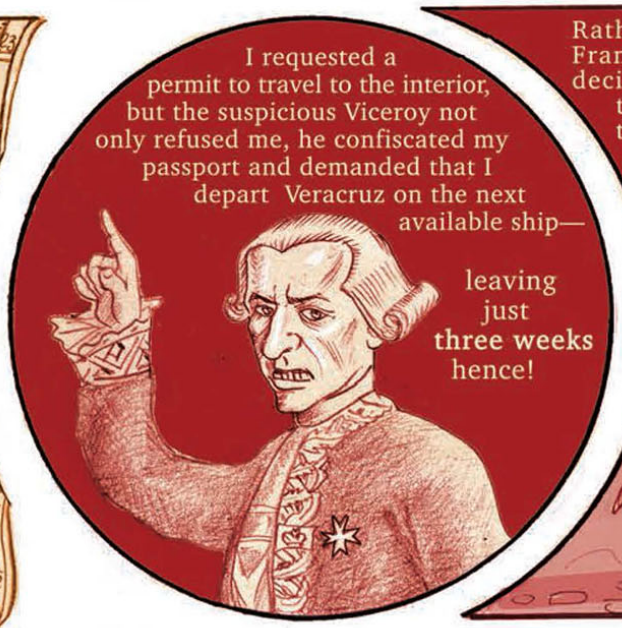
Do tell!
In 1776 a French botanist named Thiérry de Menonville, with funding from his government, sailed across the Atlantic, embarking on a mission to steal the source of Spain's secret dye...
He chronicled this daring adventure in his book, Travels to Oaxaca...
I spent months trying to find it with no success. But fortune smiled upon me when I overheard some merchants in a bar discussing their favored source of the dye...
Best I've found, mate, burp comes from Oaxaca...
I learned Oaxaca was a three-hundred mile trek south of Veracruz.
NOVA HISPANIA
Veracruz
Río Blanco
Oaxaca
I was making admirable progress toward my goal, when I was almost derailed...
Her charms had a disorienting affect on my senses.
But I regained my composure and forged on...
and did not look back—it was madness!

It took an exhausting sixty-six days to reach Saint-Domingue. By then I was tired and disgusted by the sea. I made my way to Cuba, posing as a botanist in search of natural remedies and managed to obtain papers allowing me entry to New Spain's gateway port, Veracruz...

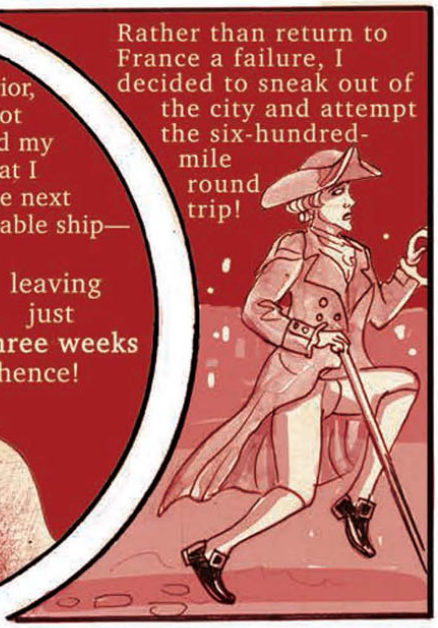


Continuing my ruse, I wandered Veracruz always with a plant and magnifying glass in hand. Remarkably, I in fact discovered a jalapa root which alleviated constipation. This rendered me famous throughout the city and increased the believability of my charade as I searched for the origin of that priceless red!

I requested a permit to travel to the interior, but the suspicious Viceroy not only refused me, he confiscated my passport and demanded that I depart Veracruz on the next available ship— leaving just three weeks hence!



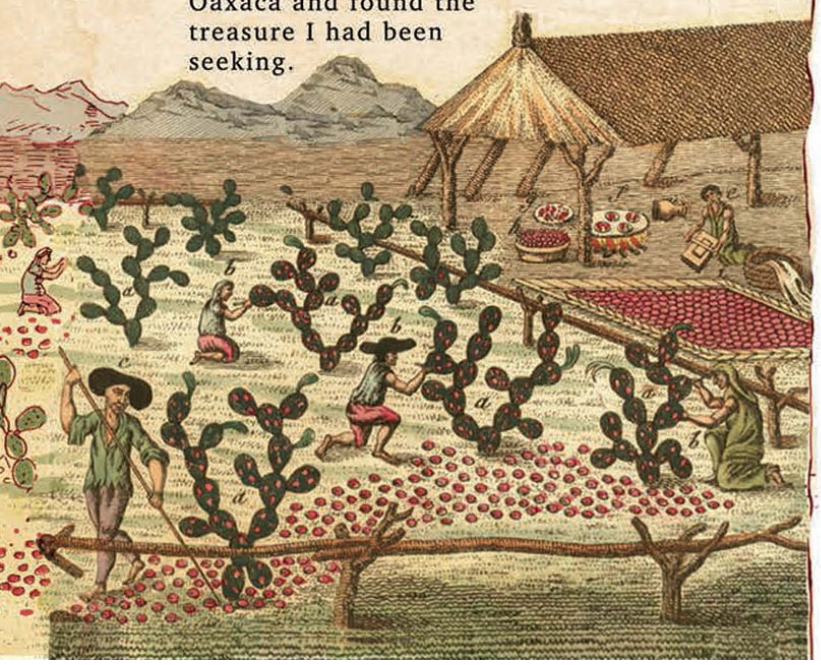
Rather than return to France a failure, I decided to sneak out of the city and attempt the six-hundred-mile round trip!



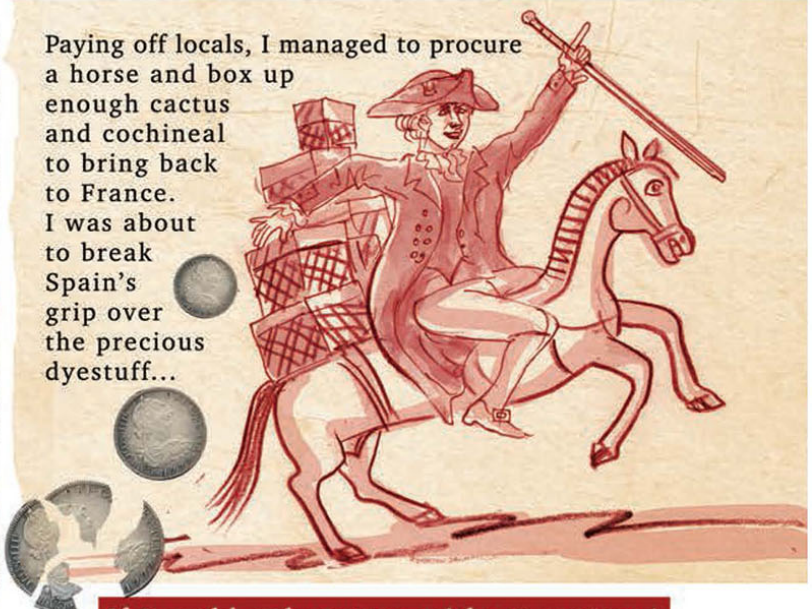
It was an arduous journey through forests and rain with little food or shelter.

I had to avoid roads, for I knew that if I were caught by authorities, it would mean certain death!

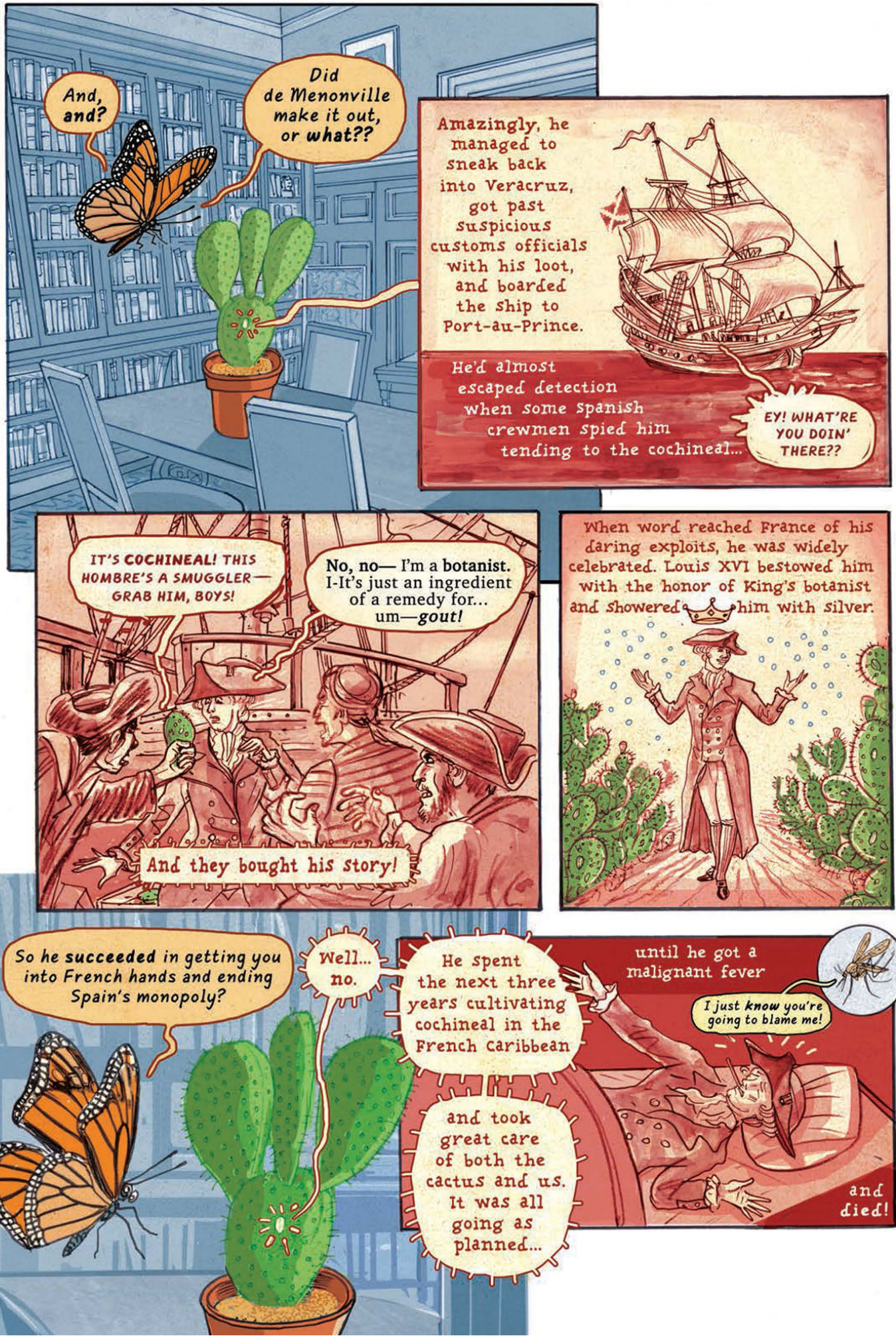
With no time to spare I at last arrived in Oaxaca and found the treasure I had been seeking.

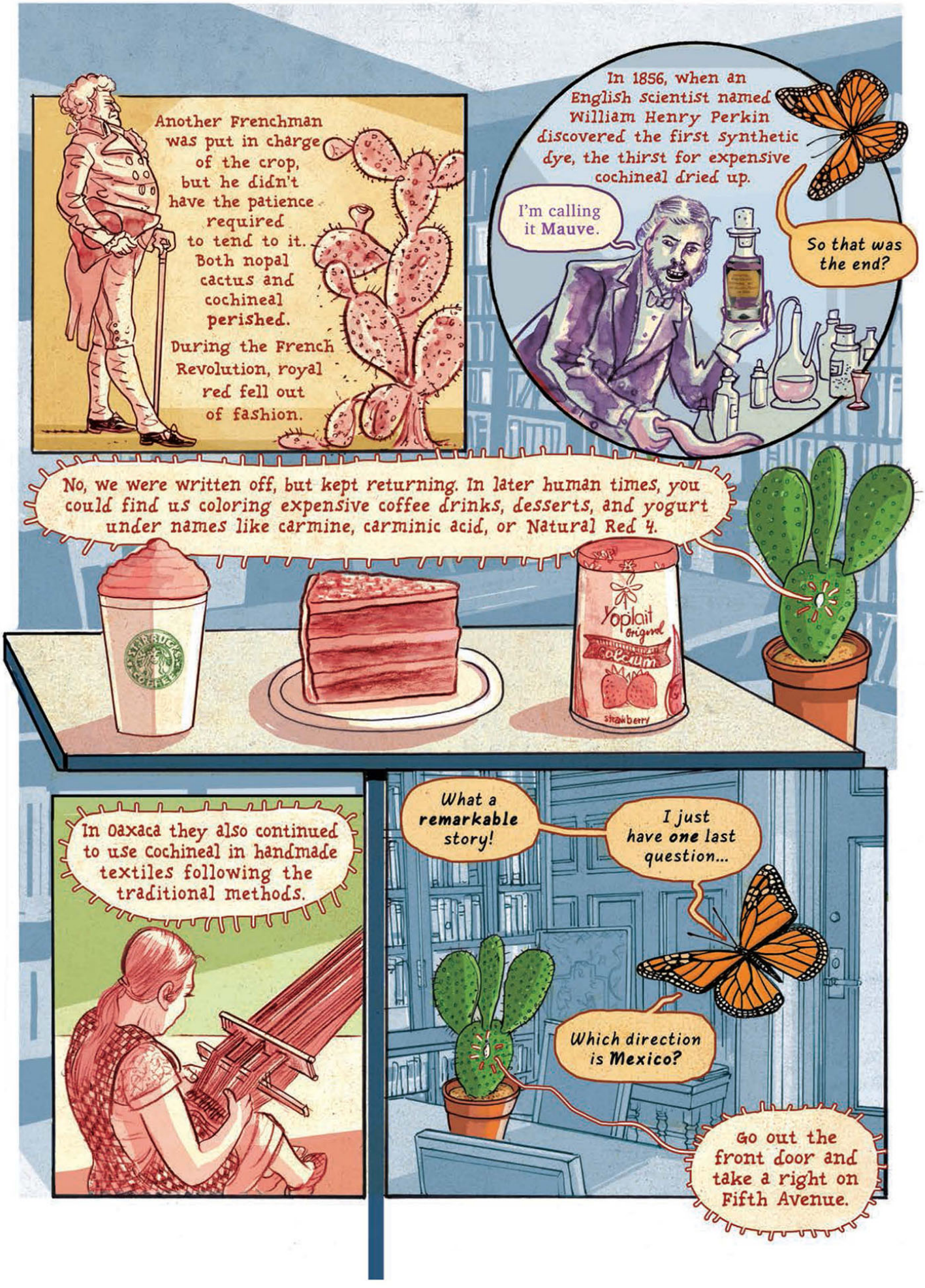


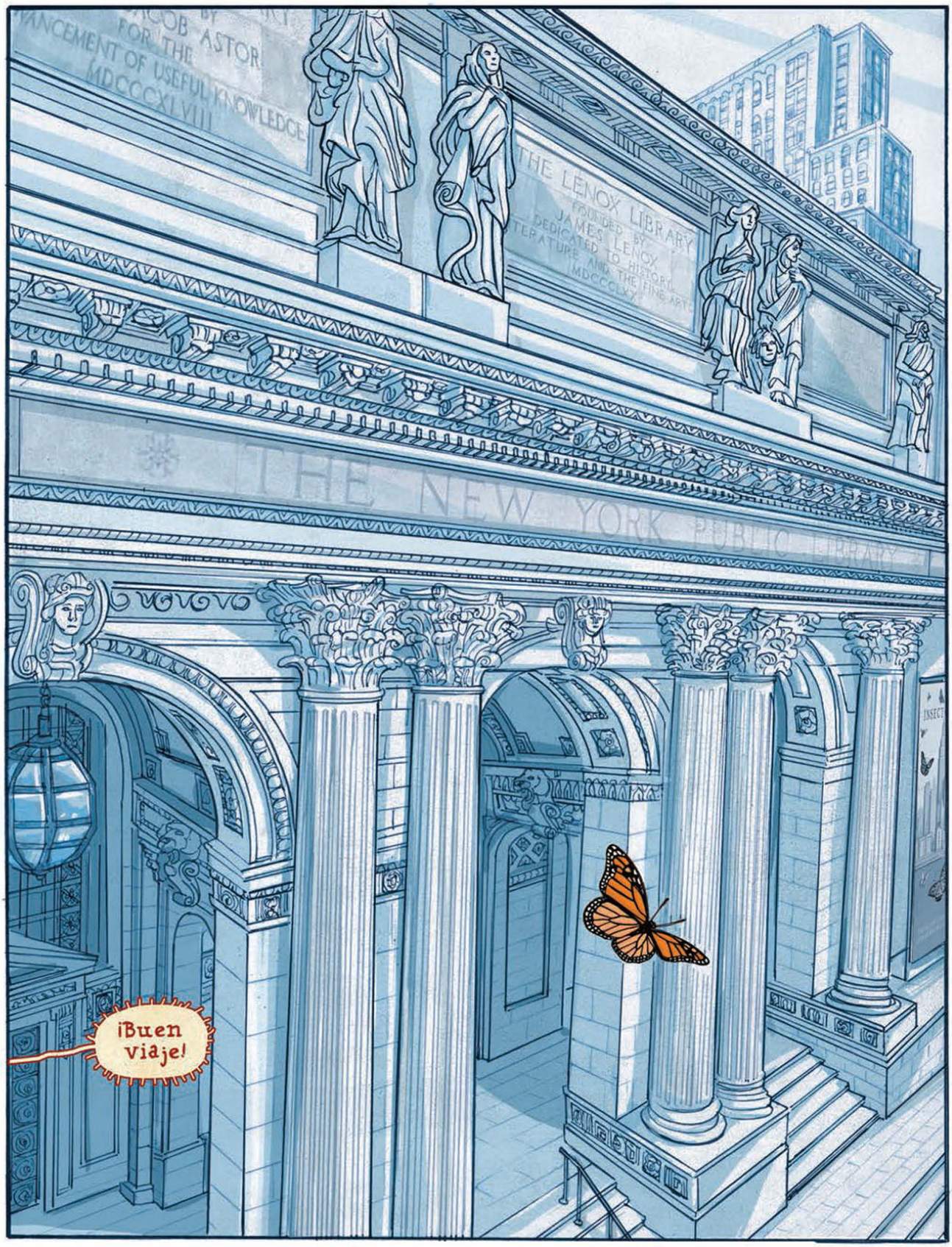
Paying off locals, I managed to procure a horse and box up enough cactus and cochineal to bring back to France. I was about to break Spain's grip over the precious dyestuff...

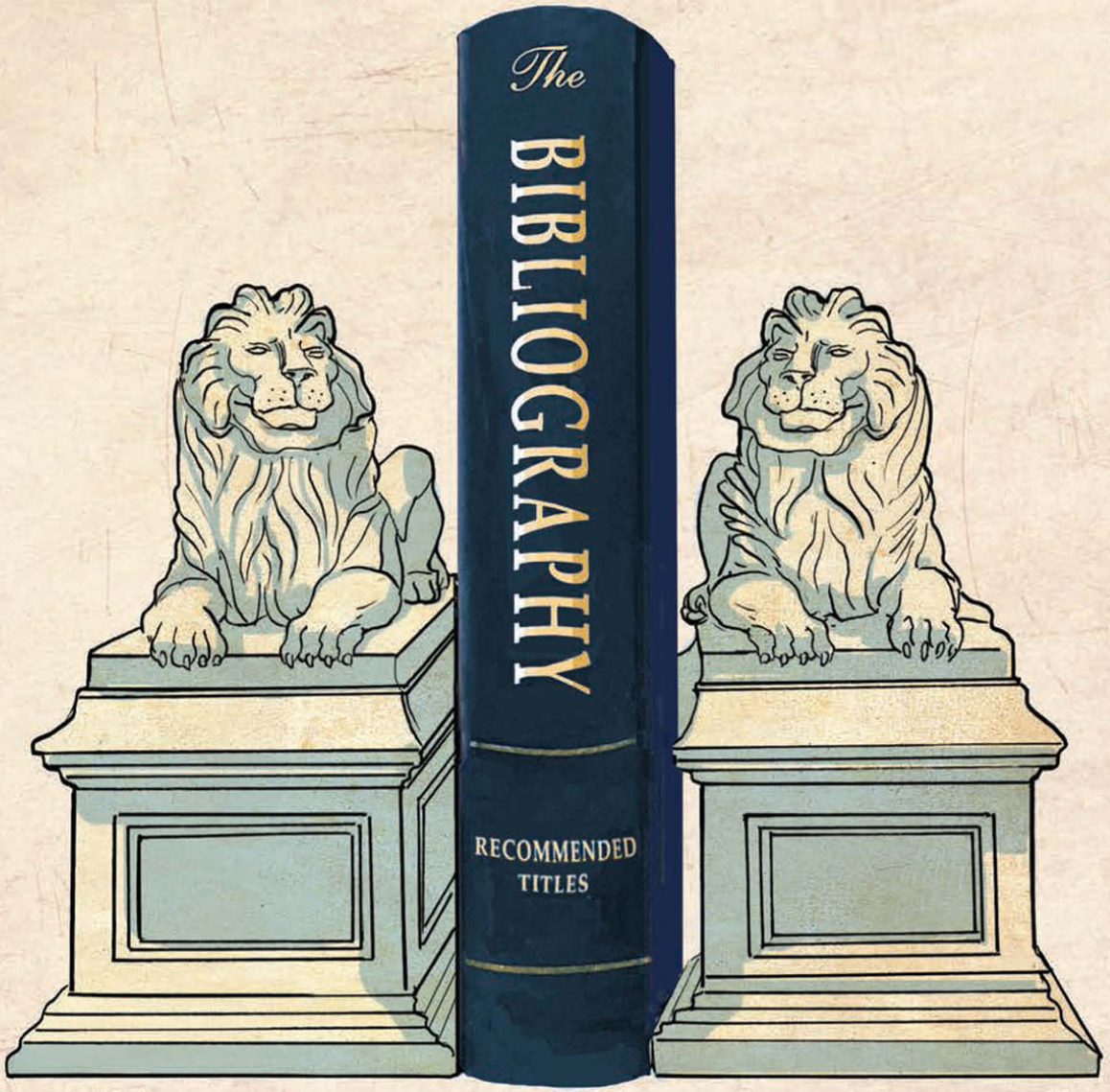


If I could only return without capture!


And, and?
Did de Menonville make it out, or what??
Amazingly, he managed to sneak back into Veracruz, got past suspicious customs officials with his loot, and boarded the ship to Port-au-Prince.
He'd almost escaped detection when some Spanish crewmen spied him tending to the cochineal...
EY! WHAT'RE YOU DOIN' THERE??
IT'S COCHINEAL! THIS HOMBRE'S A SMUGGLER— GRAB HIM, BOYS!
No, no— I'm a botanist. I-It's just an ingredient of a remedy for... um—gout!
And they bought his story!
When word reached France of his daring exploits, he was widely celebrated. Louis XVI bestowed him with the honor of King's botanist and showered him with silver.
So he succeeded in getting you into French hands and ending Spain's monopoly?
Well... no.
He spent the next three years cultivating cochineal in the French Caribbean
and took great care of both the cactus and us. It was all going as planned...
until he got a malignant fever
I just know you're going to blame me!
and died!


Another Frenchman was put in charge of the crop, but he didn't have the patience required to tend to it. Both nopal cactus and cochineal perished.
During the French Revolution, royal red fell out of fashion.
In 1856, when an English scientist named William Henry Perkin discovered the first synthetic dye, the thirst for expensive cochineal dried up.
I'm calling it Mauve.
So that was the end?
No, we were written off, but kept returning. In later human times, you could find us coloring expensive coffee drinks, desserts, and yogurt under names like carmine, carminic acid, or Natural Red 4.
Yoplait original
calcium
strawberry
In Oaxaca they also continued to use cochineal in handmade textiles following the traditional methods.
What a remarkable story!
I just have one last question...
Which direction is Mexico?
Go out the front door and take a right on Fifth Avenue.


¡Buen viaje!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A BOOK IS A DREAM YOU HOLD IN YOUR HAND
~ NEIL GAIMAN

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An Inordinate Fondness for Beetles
BEATLES

¡Qué interesante!
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MONARCHS & MILKWEED
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THE END OF NATURE
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S-S-S-
E-E-E-
X-X-X?
BUG MUSIC
HOW INSECTS GAVE US RHYTHM AND NOISE
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Memoirs of Black Entomologists: Reflections on Childhood, University, and Career Experiences
THE BUTTERFLY EFFECT
INSECTS AND THE MAKING OF THE MODERN WORLD
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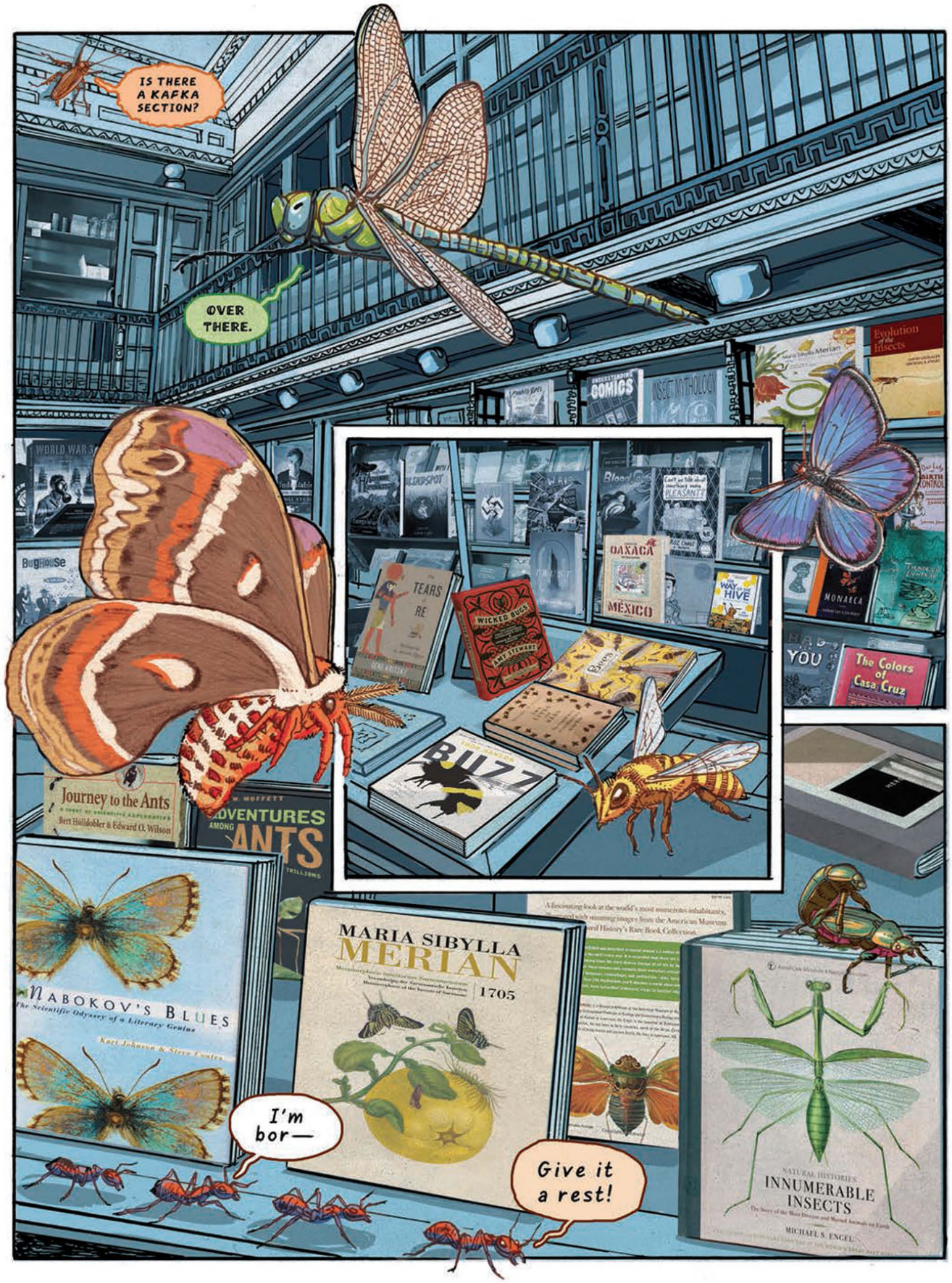
I'm bored.
I'm looking for childrens' books...


IS THERE A KAFKA SECTION?
OVER THERE.
Evolution of the Insects
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BugHouse
TEARS
WICKED BUGS
OAXACA
MEXICO
WAY OF THE HIVE
MONARCA
YOU
The Colors of Casa Cruz
BUZZ
Journey to the Ants
Bert Hölldobler & Edward O. Wilson
ANTS
NABOKOV'S BLUES
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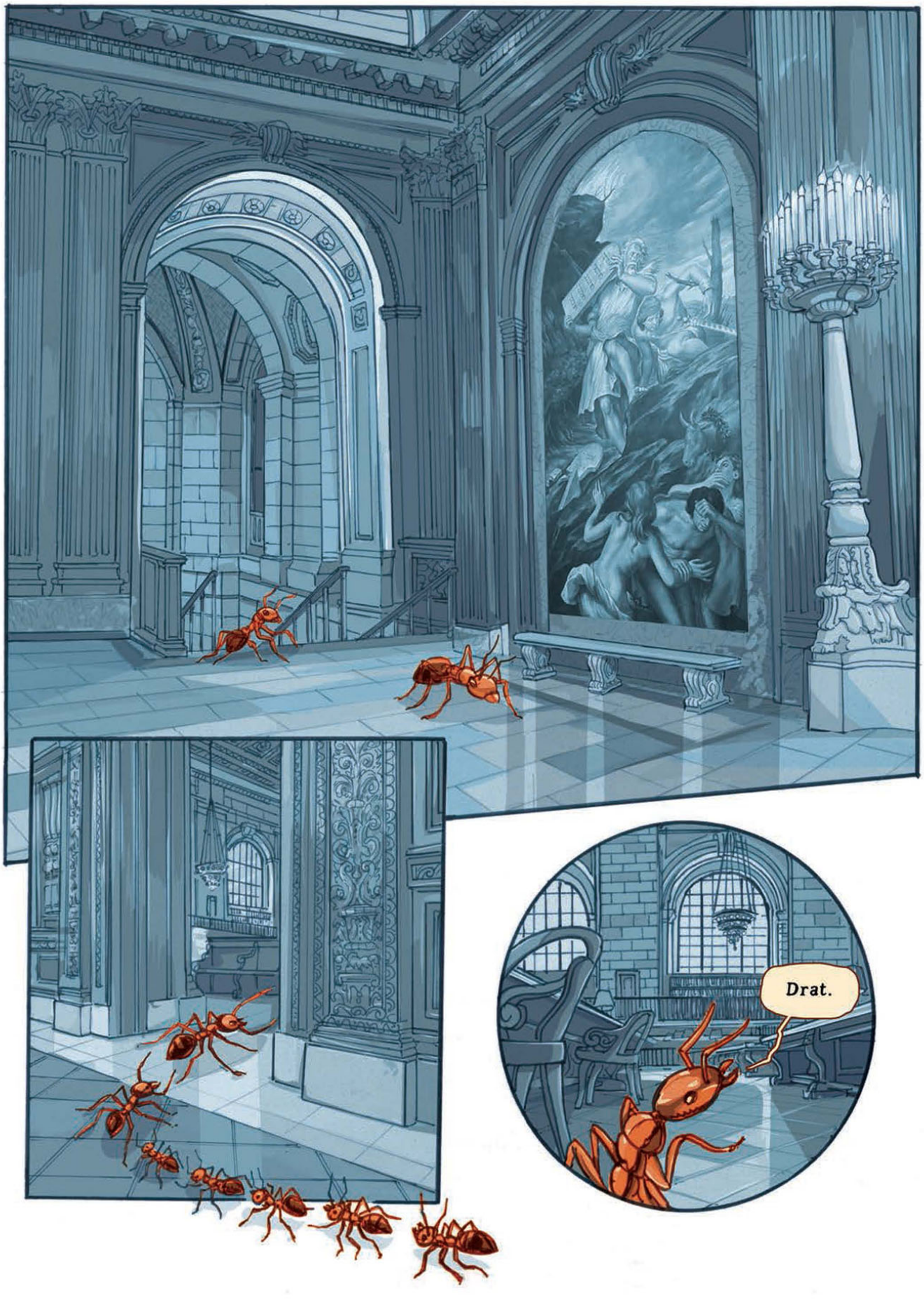
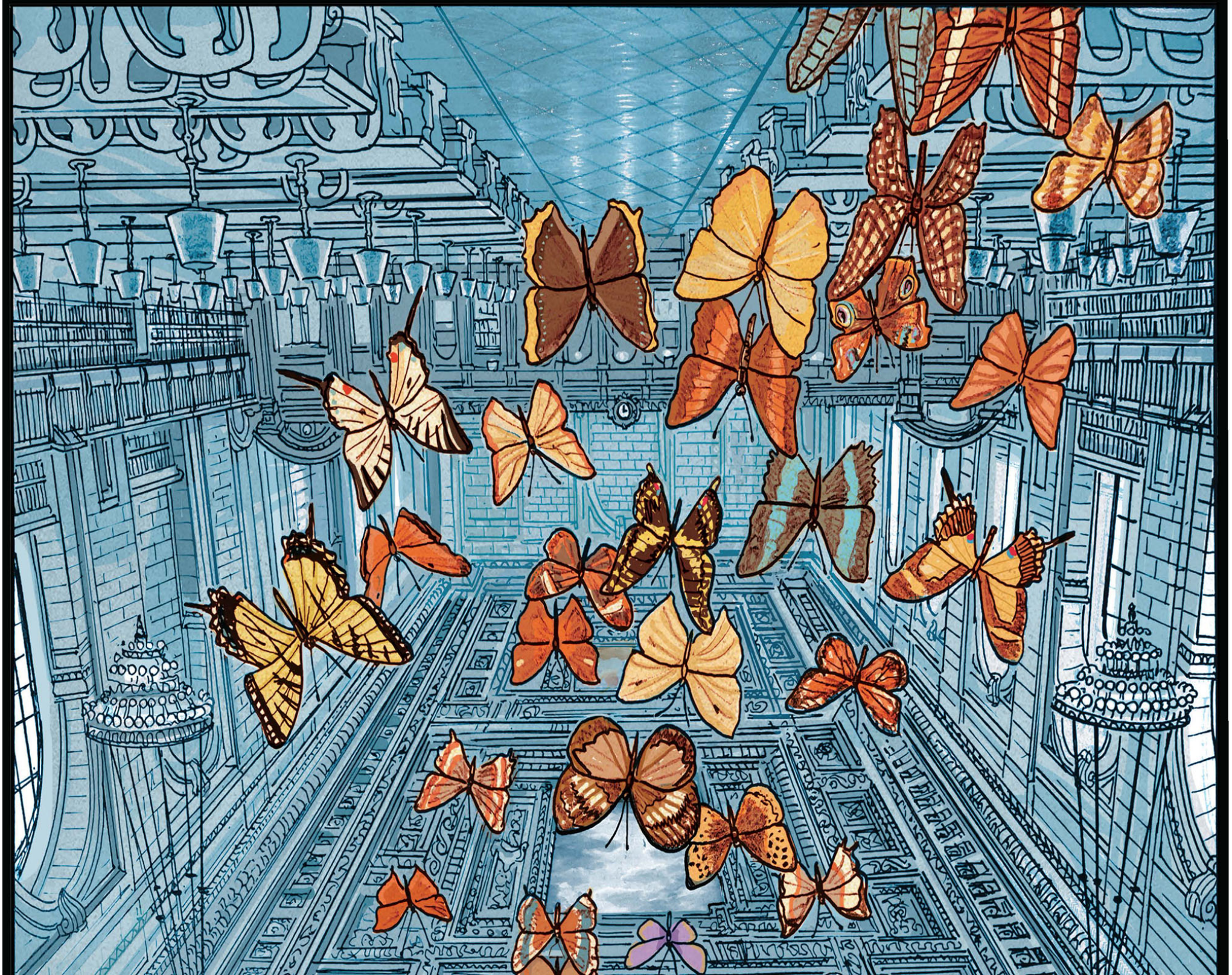
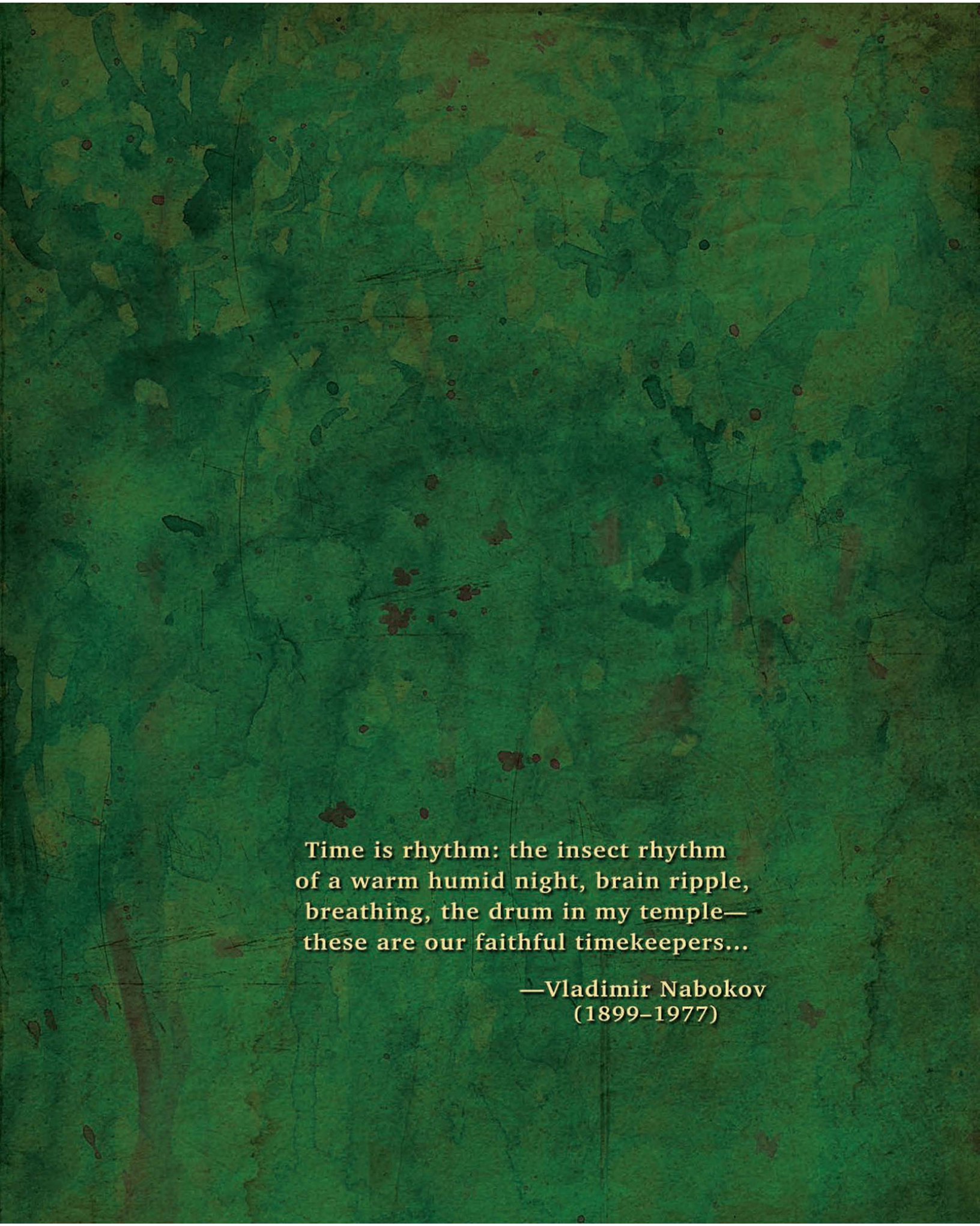
MARIA SIBYLLA MERIAN
1705
I'm bor—
Give it a rest!
NATURAL HISTORIES
INNUMERABLE INSECTS
MICHAEL S. ENGEL

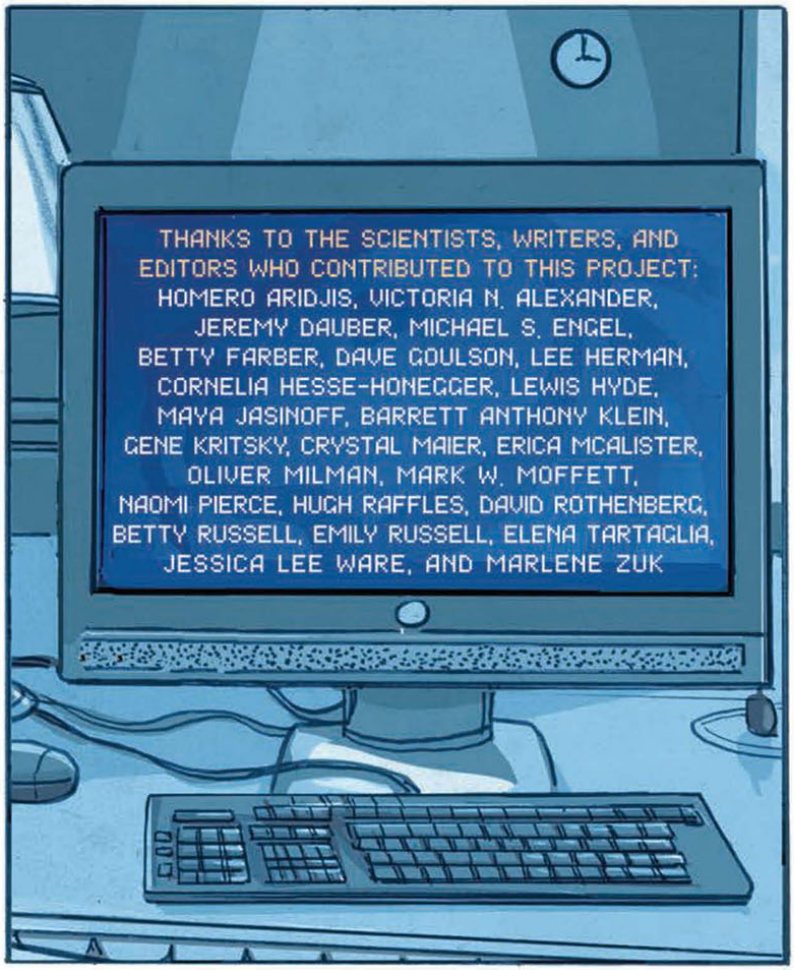
THE BIG BOOK OF BUGS
SAM AND THE FIREFLY
P.D EASTMAN
and
don marquis
A DAY IN THE LIFE
Bugs
the BUG GIRL
MONARCH BUTTERFLIES
The LEAF MEN
The Cricket in Times Square
George Selden
ALICIA
Lewis Carroll
The GIRL WHO DREW BUTTERFLIES
How Maria Merian's Art Changed Science
Bees
Charlotte's Web
E. B. White
Garth Williams
BUZZING WITH QUESTIONS
THE BEE BUZZ
MUNCH MUNCH
THE VERY HUNGRY CATERPILLAR
by Eric Carle
MARÍA the Monarch
Sapiens
ROBOPOCALYPSE
DANIEL H. WILSON
TWO BAD ANTS
Hey, this isn't a children's book.
Let's go, girls...
I want to avoid rush hour.


Drat.




Time is rhythm: the insect rhythm
of a warm humid night, brain ripple,
breathing, the drum in my temple—
these are our faithful timekeepers...
—Vladimir Nabokov
(1899–1977)

COMPUTER—
ANY ACKNOWLEDG-MENTS?
CHECKING...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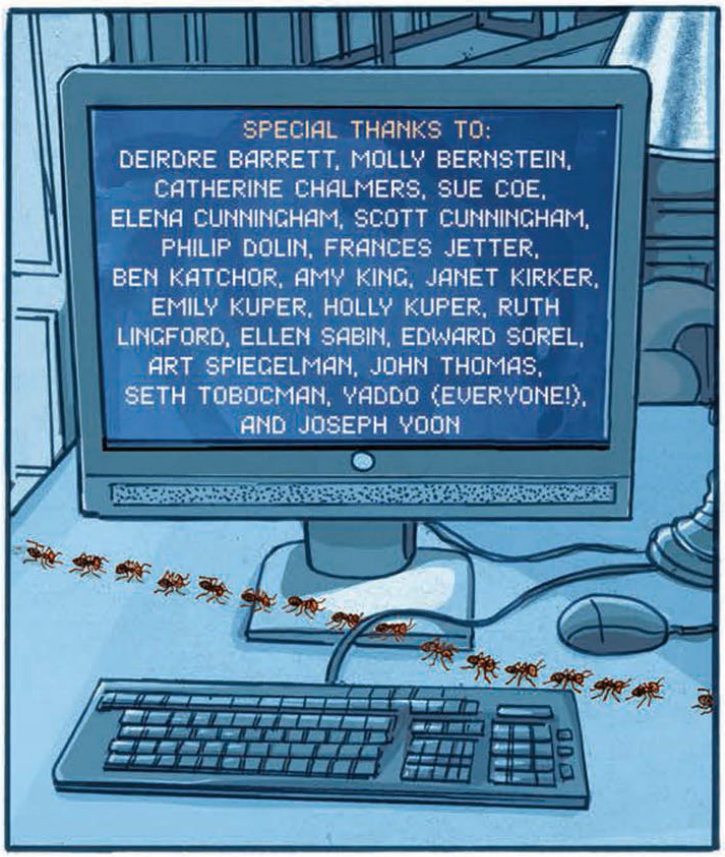
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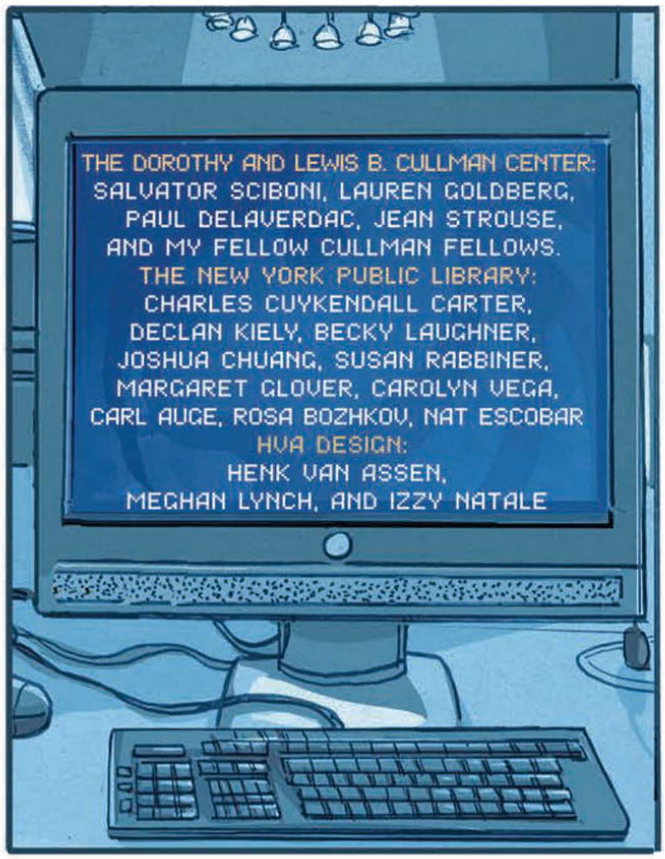
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He has also created adaptations of Upton Sinclair's *The Jungle*,
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Franz Kafka's works, including *The Metamorphosis*
and fourteen short stories collected in *Kafkaesque*.
He has written and illustrated "Spy vs. Spy" for *Mad* magazine since 1997
and is the cofounder with Seth Tobocman of *World War 3 Illustrated*,
a graphics magazine that has been giving a forum
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Kuper has received the 2024 RFK Human Rights Award for cartooning,
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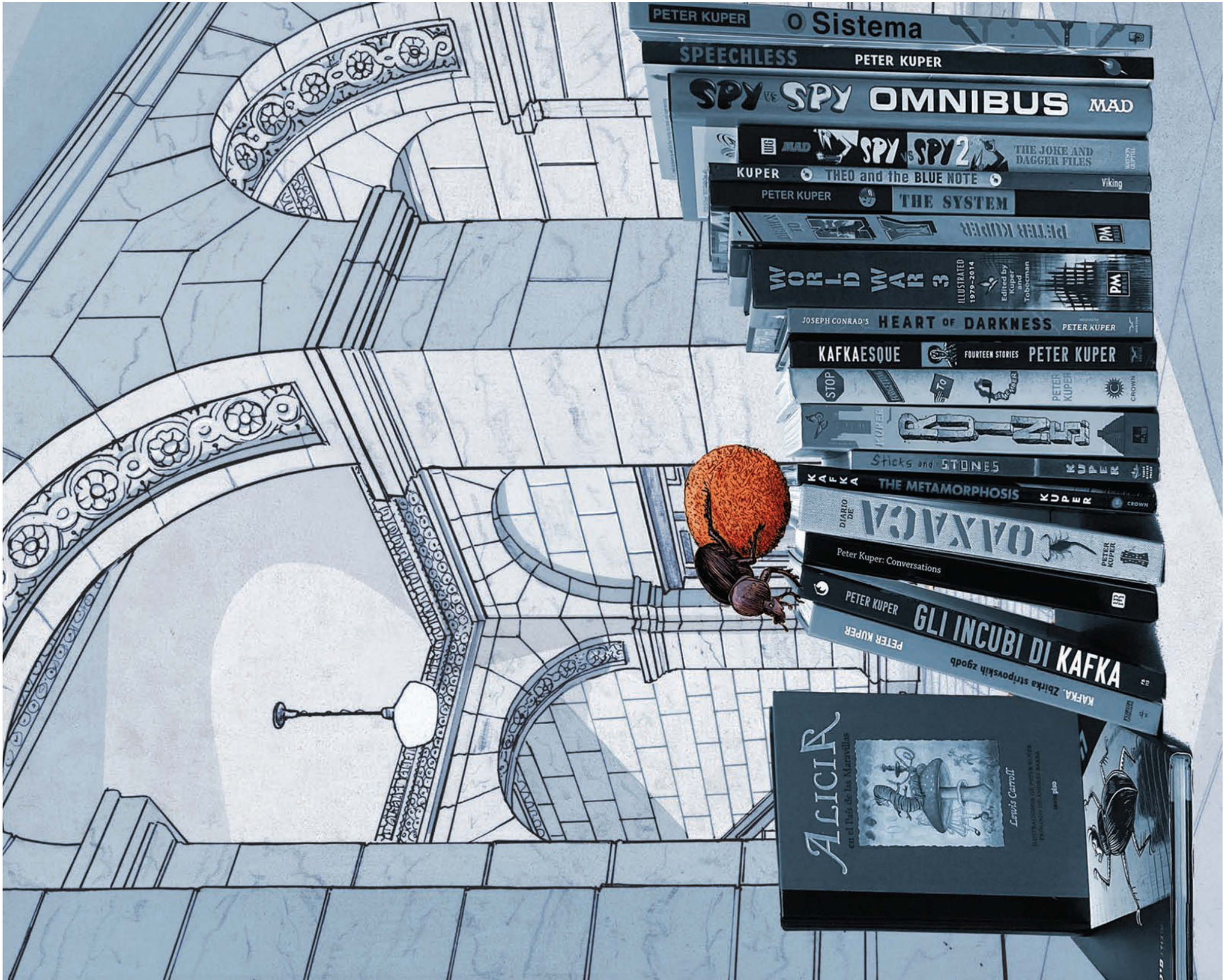
at the New York Public Library.
He has lectured widely and exhibited his work around the world.
He teaches cartooning at Harvard University.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